DRAFT

Treatability Study in Support of Remediation by Natural Attenuation for Groundwater at Site LF-06

AIR CENTER FOR ENVIRONMENTAL EXCELLENCE

Columbus Air Force Base
Columbus, Mississippi

Prepared For

Air Force Center for Environmental Excellence
Technology Transfer Division
Brooks Air Force Base
San Antonio, Texas

and

Columbus Air Force Base
Columbus, Mississippi

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DRAFT

TREATABILITY STUDY IN SUPPORT OF REMEDIATION BY NATURAL ATTENUATION FOR GROUNDWATER AT SITE LF-06

at

COLUMBUS AIR FORCE BASE
COLUMBUS, MISSISSIPPI

AUGUST 1997

Prepared for:

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
TECHNOLOGY TRANSFER DIVISION
BROOKS AIR FORCE BASE
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EXECUTIVE SUMMARY

This report presents the results of a treatability study (TS) performed by Parsons Engineering Science, Inc. (Parsons ES) at Site LF-06, Columbus Air Force Base, Mississippi, to evaluate remediation by natural attenuation (RNA) of dissolved fuel-hydrocarbons and chlorinated aliphatic hydrocarbons (CAHs) in groundwater. The TS focused on the fate and transport of dissolved CAHs, particularly trichloroethene (TCE), chlorobenzene (CB), and vinyl chloride (VC); however, petroleum hydrocarbons [including benzene, toluene, ethylbenzene, and xylenes (BTEX)] also are present in site groundwater and were considered. The site history and the results of the soil and groundwater investigations conducted previously also are summarized in this report.

Comparison of CAH, BTEX, electron acceptor, and biodegradation byproduct isopleth maps for LF-06 provides strong qualitative evidence of biodegradation of dissolved CAHs. These geochemical data strongly suggest that reductive dehalogenation of dissolved CAHs is occurring at the site as microbes utilize natural organic carbon, BTEX, and other fuel hydrocarbons as substrates. Patterns observed in the distribution of CAHs, daughter products of CAHs, electron acceptors, and biodegradation byproducts also suggest that biotic and abiotic dehydrohalogenation may also be acting to reduce the concentration of CAHs dissolved in site groundwater. Field-scale first-order decay rates computed using data from LF-06 included a total BTEX biodegradation rate of 0.053 day^{-1}, a chlorobenzene biodegradation rate of 0.010 day^{-1}, and a total chlorinated ethene dechlorination rate of 0.0035 day^{-1}. The equivalent half-lives are 0.35 years, 0.19 years, and 0.54 years, respectively.

An important component of this study was an assessment of the potential for contamination in groundwater to migrate from the source areas to potential receptor exposure points (i.e., off-Base locations to the south and west of Site LF-06). An analytical model was used to evaluate the fate and transport of dissolved CAHs and

BTEX in the shallow groundwater under the influence of advection, dispersion, sorption, and biodegradation. Input parameters for the model were obtained from site data collected by Parsons ES. Model parameters that were not measured at the site were estimated using reasonable literature values.

The results of this demonstration suggest that RNA of dissolved CAHs and BTEX contamination is occurring at Site LF-06; furthermore, the estimated rates of biodegradation, when coupled with sorption, dispersion, and dilution, should be sufficient to reduce and maintain dissolved contamination concentrations to levels below current regulatory guidelines long before potential downgradient or off-site receptors could be adversely affected. Conservative modeling suggests that under current conditions, the concentrations of the groundwater contaminant plume will drop below MCLs within, at most, 1,000 feet downgradient from the edge of the landfill. Future site activities are not anticipated to change, and the risk to any Base personnel would be minimal, provided institutional controls for soil and groundwater are maintained. Institutional controls such as restrictions on shallow groundwater use at the site would prevent completion of receptor exposure pathways until RNA is complete. The Air Force therefore recommends implementation of RNA and long-term monitoring (LTM) with institutional controls.

To verify model predictions, and to ensure that the selected technologies are meeting objectives, the Air Force recommends using 10 LTM wells and 4 sentry wells to monitor the long-term migration and degradation of the dissolved hydrocarbon plume. In addition to analyses used to verify the effectiveness of RNA, the groundwater samples should be analyzed for CAH and BTEX compounds by US Environmental Protection Agency (USEPA) Method SW8260. If data collected under the LTM program indicate that the selected remedial system is not sufficient to reduce BTEX concentrations at downgradient well locations to levels considered protective of human health and the environment, additional corrective actions may be required to remediate groundwater at the site.

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ACRONYMS AND ABBREVIATIONS

μg/kg	micrograms per kilogram
μg/L	micrograms per liter
AETC	Air Education and Training Command
AFB	Air Force Base
AFCEE	United States Air Force Center for Environmental Excellence
ASCII	American Standard Code for Information Interchange
ATC	Air Training Command
atm-m^3/mol	atmosphere-cubic meters per mole
bgs	below ground surface
BRAC	Base Realignment and Closure
BTEX	benzene, toluene, ethylbenzene, and xylenes
°C	degrees Centigrade
$CaCO_3$	calcium carbonate
CA	chloroethane
CAH	chlorinated aliphatic hydrocarbon
CB	chlorobenzene
DCA	dichloroethane
DCB	dichlorobenzene
DCE	dichloroethene
DCM	dichloromethane
DO	dissolved oxygen
ESE	Environmental Science and Engineering, Inc.
ft/day	feet per day
ft/ft	foot per foot
$\Delta G°r$	Gibbs free energy of the reaction
HDPE	high density polyethylene
ID	inside diameter
IRP	Installation Restoration Program
LF-06	Landfill 6
LTM	long-term monitoring
MCL	maximum contaminant level
MDEQ	Mississippi Department of Environmental Quality
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mm Hg	millimeters of mercury
msl	mean sea level
N	nitrogen
NAPL	nonaqueous-phase liquid
OH^-	hydroxyl group
Parsons ES	Parsons Engineering Science, Inc.
PA/SI	preliminary assessment/site inspection

PCA	tetrachloroethane
PCE	tetrachloroethene
PID	photoionization detector
PVC	polyvinyl chloride
QC	quality control
RAO	remedial action objective
redox	reduction/oxidation
RI	remedial investigation
RNA	remediation by natural attenuation
SAC	Strategic Air Command
SAP	Sampling and Analysis Plan
SS	stainless steel
SVE	soil vapor extraction
TCA	trichloroethane
TCB	trichlorobenzene
TCE	trichloroethene
TeCB	tetrachlorobenzene
TEMB	tetramethylbenzene
TMB	trimethylbenzene
TOC	total organic carbon
TRPH	total recoverable petroleum hydrocarbons
TS	Treatability Study
TVH	total volatile hydrocarbons
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
VC	vinyl chloride
VOC	volatile organic compound

SECTION 1

INTRODUCTION

This Treatability Study (TS) was conducted by Parsons Engineering Science, Inc. (Parsons ES) to evaluate remediation by natural attenuation (RNA) of fuel-hydrocarbon and chlorinated-solvent contaminated groundwater at Landfill 6 (LF-06) at Columbus Air Force Base (AFB), Mississippi. As used in this report, RNA refers to a management strategy that relies on natural attenuation mechanisms to remediate contaminants dissolved in groundwater and to control receptor exposure risks associated with contaminants in the subsurface. The United States Environmental Protection Agency (USEPA) defines natural attenuation as (Wilson, 1996):

> *The naturally-occurring processes in soil and groundwater environments that act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in those media. These in-situ processes include biodegradation, dispersion, dilution, adsorption, volatilization, and chemical or biological stabilization or destruction of contaminants.*

As suggested by this definition, mechanisms for natural attenuation include both destructive and non-destructive processes. Non-destructive processes may reduce contaminant toxicity, mobility, volume, or concentration; however, mass is unaffected. Of these processes, biodegradation is the most common mechanism working to transform fuel hydrocarbons and chlorinated solvents into innocuous byproducts. Contaminant destruction occurs through biodegradation when indigenous microorganisms work to bring about a reduction in the total mass of contamination in the subsurface without artificial intervention (e.g., the addition of nutrients). Patterns and rates of natural attenuation can vary markedly from site to site, and within a single

contaminant plume at a given site, depending on governing physical and chemical processes.

1.1 SCOPE AND OBJECTIVES

Parsons ES was retained by the United States Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division to conduct site characterization and groundwater modeling to evaluate the scientific defensibility of RNA with long-term monitoring (LTM) as a component of remediation for contaminated groundwater at Columbus AFB. The primary objective of this project was to determine the degree to which natural attenuation processes for fuel hydrocarbons and chlorinated solvents are occurring in groundwater at the site. Performance of the following tasks was required to fulfill the project objectives:

- Reviewing previously reported hydrogeologic, soil, and groundwater data for the site;
- Conducting supplemental site characterization activities to more thoroughly characterize the nature and extent of soil and groundwater contamination;
- Collecting geochemical data in support of RNA;
- Developing a conceptual hydrogeologic model of the shallow saturated zone, including the current distribution of contaminants;
- Evaluating site-specific data to determine whether natural processes of contaminant attenuation and destruction are occurring in groundwater for dissolved concentrations of fuel hydrocarbon and chlorinated solvent compounds at the site;
- Calibrating an analytical flow and transport model to replicate observed site conditions;

- Simulating the fate and transport of benzene, toluene, ethylbenzene, and xylenes (BTEX) and chlorinated solvents in groundwater under the influence of biodegradation, advection, dispersion, and adsorption using the calibrated flow and transport model;

- Evaluating a range of model input parameters to determine the sensitivity of the model to those parameters and to consider several contaminant fate and transport scenarios;

- Determining if natural processes are sufficient to reduce dissolved hydrocarbon and chlorinated solvent plume expansion so that water quality standards can be met at a downgradient location;

- Simulating the effects of candidate remedial technologies and comparing results to preliminary remedial action objectives (RAOs);

- Using the results of modeling to recommend the most appropriate remedial option based on specific effectiveness, implementability, and cost criteria; and

- Providing a LTM plan that includes LTM and sentry well locations and a sampling and analysis plan.

The field work conducted under this program was oriented toward collecting supplementary hydrogeological and chemical data necessary to document and model natural attenuation mechanisms currently operating at the site. During November 1996, site characterization activities included use of the Geoprobe® direct-push technology for soil sample collection and temporary monitoring point installation; aquifer testing; and sampling and analysis of groundwater from temporary groundwater monitoring points and previously installed monitoring wells. Much of the hydrogeological and groundwater chemical data necessary to evaluate RNA were

available from previous investigations conducted at this site, at other sites with similar characteristics, or in technical literature.

Site-specific chemical evidence was first used to qualitatively evaluate destructive natural attenuation mechanisms, and to deduce the types of destructive mechanisms operating to reduce chlorinated solvents and fuel hydrocarbon mass at the site. Finally the chemical evidence was used to approximate destructive attenuation rates.

Following the chemical evaluation, site-specific hydrogeologic and chemical data were used to develop an analytical fate and transport model for the site to evaluate processes of natural attenuation. The modeling effort was used to simulate the movement of dissolved contaminants in the shallow saturated zone under the influence of biodegradation, advection, dispersion, and sorption. Results of the model were used to assess the potential for completion of exposure pathways involving groundwater and to determine whether RNA with LTM is an appropriate and defensible remedial option for contaminated groundwater. The results will be used to provide technical support for the RNA with LTM remedial option during regulatory negotiations, as appropriate.

This report contains nine sections, including this introduction, and five appendices. Section 2 summarizes site characterization activities. Section 3 summarizes the physical characteristics of the study area. Section 4 describes the nature and extent of soil and groundwater contamination and the geochemistry of soil and groundwater at the site. Section 5 describes the fate and transport model and design of the conceptual model for the site, lists model assumptions and input parameters, and describes sensitivity analyses. Section 6 presents a comparative analysis of remedial alternatives and predictive model results. Section 7 presents the LTM plan for the site. Section 8 presents the conclusions of this work and provides recommendations for further work at the site. Section 9 lists the references used to develop this document. Appendix A contains Geoprobe® borehole logs, monitoring point installation records, and slug test results. Appendix B presents soil and groundwater analytical results. Appendix C

contains calculations and model input parameters. Appendix D contains model input and output in American Standard Code for Information Interchange (ASCII) format on a diskette. Appendix E contains calculations for remedial option design and costing.

1.2 FACILITY BACKGROUND

Columbus AFB is in northeastern Mississippi, in the northwestern portion of Lowndes County (Figure 1.1). Columbus AFB covers approximately 4,411 acres in a lightly urbanized area 10 miles north of Columbus, Mississippi. Columbus AFB was initially activated on February 9, 1942 as a pilot training facility. It was closed in 1946 and remained inactive until 1951, when it was reopened as a contract flying school operated by California Eastern Airways, Inc. On April 1, 1955, the United States Air Force (USAF) Air Training Command (ATC) transferred the Base to the Second Air Force of the Strategic Air Command (SAC). An active building program was instituted by SAC to prepare the Base for its mission as the home of a B-52 squadron and a KC-135 tanker squadron, both of which arrived in 1959. ATC regained jurisdiction of the Base on July 1, 1969. The training missions at Columbus AFB require the use and maintenance of T-1, T-37, T-38, and AT-38 training aircraft. ATC became the Air Education and Training Command (AETC) on July 1, 1993. Base Realignment and Closure (BRAC) decisions in 1991, 1993, and 1995 continue to impact the mission and structure of the Base (Spencer, 1996b).

Site LF-06, Landfill Number 6, is located near the southeastern corner of the Base, directly south of the main runway and near the main gate. The landfill was operated as a disposal area for sanitary trash, ferrous metal debris, and concrete debris from 1964 through 1974. North-south trenches 8 to 10 feet deep were used for trash disposal. Initial trenches were created on the western side of the landfill, and subsequent filling activities proceeded in an easterly direction. No trenches on the east side of the landfill were used because of a near-surface water table (2 feet below the surface) (CH2M Hill, 1989). The landfill is covered by grass, with trees and thick vegetation covering the east and south portions of the landfill.

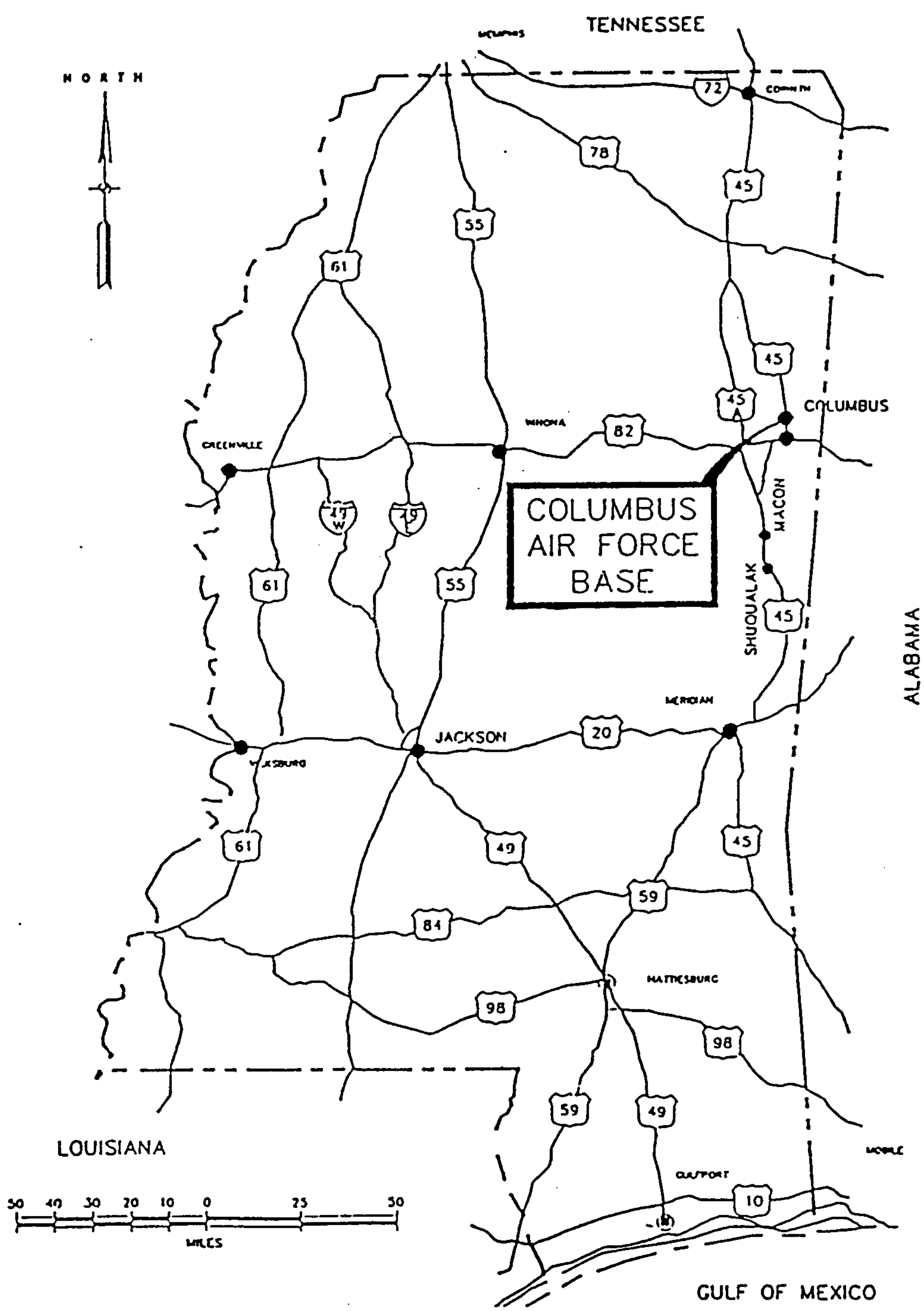

FIGURE 1.1

LOCATION OF COLUMBUS AFB

Site LF-06 RNA TS
Columbus AFB, Mississippi

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Denver, Colorado

In 1985, a preliminary assessment/site inspection (PA/SI) was conducted by Environmental Science and Engineering, Inc. (ESE) as part of the Installation Restoration Program (IRP). The PA/SI identified 15 potentially contaminated sites, including Site LF-06. In 1988 and 1989, a remedial investigation (RI) was conducted by CH2M Hill (1989) to investigate the 15 sites identified in the PA/SI. As part of the RI activities, a geophysical survey was conducted to delineate the landfill boundary (Figure 1.2). In April 1988, nine sediment samples and two surface water samples were collected along drainageways east and south of the site, and five monitoring wells were installed and sampled. The monitoring wells were sampled again in July 1988 and December 1988. In May 1989, three additional monitoring wells were installed to further evaluate the extent of vinyl chloride and mercury in groundwater in the vicinity of Site LF-06, and two downgradient monitoring wells were installed near the southern property boundary of the Base to determine if dissolved contamination had migrated beyond property boundaries (CH2M Hill, 1989). All site monitoring wells were sampled in August 1995 as part of the groundwater LTM program at Columbus AFB (Spencer, 1996a).

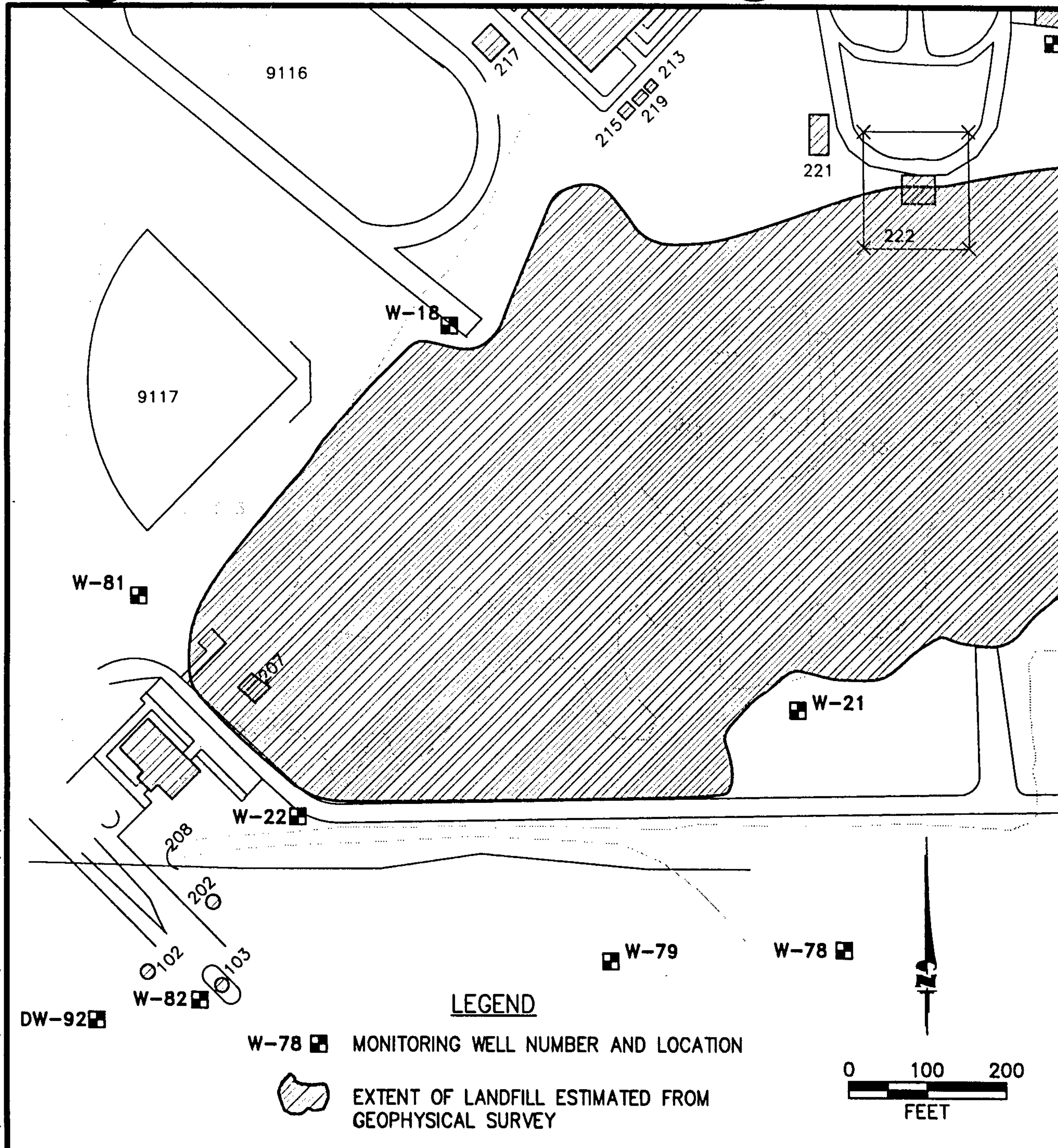

FIGURE 1.2

SITE MAP

Site LF-06 RNA TS
Columbus AFB, Mississippi

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SECTION 2

SITE CHARACTERIZATION ACTIVITIES

This section presents the methods used by Parsons ES personnel to collect site-specific data at Site LF-06 at Columbus AFB, Mississippi. The site characterization was performed in November 1996, and consisted of monitoring point installation, soil and groundwater sampling, and aquifer testing to evaluate near-surface geology and geochemistry, aquifer properties, and the extent of soil and groundwater contamination for the area surrounding LF-06. Temporary groundwater monitoring point installation and soil sampling were accomplished using the Geoprobe® direct-push system. Groundwater sampling was accomplished using both temporary monitoring points and previously installed monitoring wells. Hydraulic conductivity (slug) tests were conducted at several of the site monitoring wells. Previously collected data were integrated with data collected under this program to develop the conceptual site model and to aid interpretation of the physical setting (Section 3) and contaminant distribution (Section 4).

The following sections describe the procedures that were followed when collecting site-specific data. Additional details regarding investigative activities are presented in the work plan (Parsons ES, 1996).

2.1 DRILLING, SOIL SAMPLING, AND MONITORING POINT INSTALLATION

Drilling-related field work occurred between November 8 and November 17, 1996, and consisted of soil sampling and temporary groundwater monitoring point installation. Twenty-one temporary groundwater monitoring points were installed at 17 locations to assist in the characterization of the shallow groundwater flow system at Site LF-06. These points were identified as MPA(s), MPA(d), MPB, MPC(s), MPC(d), MPD(s), MPD(d),

MPF(s), MPF(d), MPG, MPH, MPI, MPJ, MPK, MPL, MPM, MPN, MPO, MPP, MPQ, and MPR. The new points were installed in the locations shown on Figure 2.1. Table 2.1 presents monitoring well completion details. Four sets of clustered points were installed, with one well (designated by the suffix "s") screened near the water table surface, and with the deeper well (designated by the suffix "d") screened at the base of the unconsolidated shallow aquifer immediately above the semi-impervious clay layer. The well locations were selected to provide the hydrogeologic data necessary for successful implementation of fate and transport modeling and to support the RNA demonstration. These activities were performed according to the procedures described in the work plan (Parsons ES, 1996) and in the following sections.

2.1.1 Geoprobe® Operation

The Geoprobe® system is a hydraulically powered percussion/probing machine used to advance sampling tools through unconsolidated soils. This system provides for the rapid collection of soil, soil gas, and groundwater samples at shallow depths while minimizing the generation of investigation-derived waste materials. For convenience, throughout this report, operation of the Geoprobe® is referred to as "drilling".

2.1.1.1 Pre-Drilling Activities

All subsurface utility lines or other man-made subsurface features were located, and proposed drilling locations were cleared and approved by the Base prior to any drilling activities. Water used in equipment cleaning or grouting was obtained from a potable water supply designated by the Base.

2.1.1.2 Equipment Decontamination Procedures

Prior to arriving at the site, and between each drilling location, all probe rods, tips, sleeves, pushrods, samplers, tools, and other downhole equipment were decontaminated using an Alconox® detergent and potable water solution followed by a potable water wash. Fittings, tips, and samplers also underwent an additional rinse with isopropyl alcohol

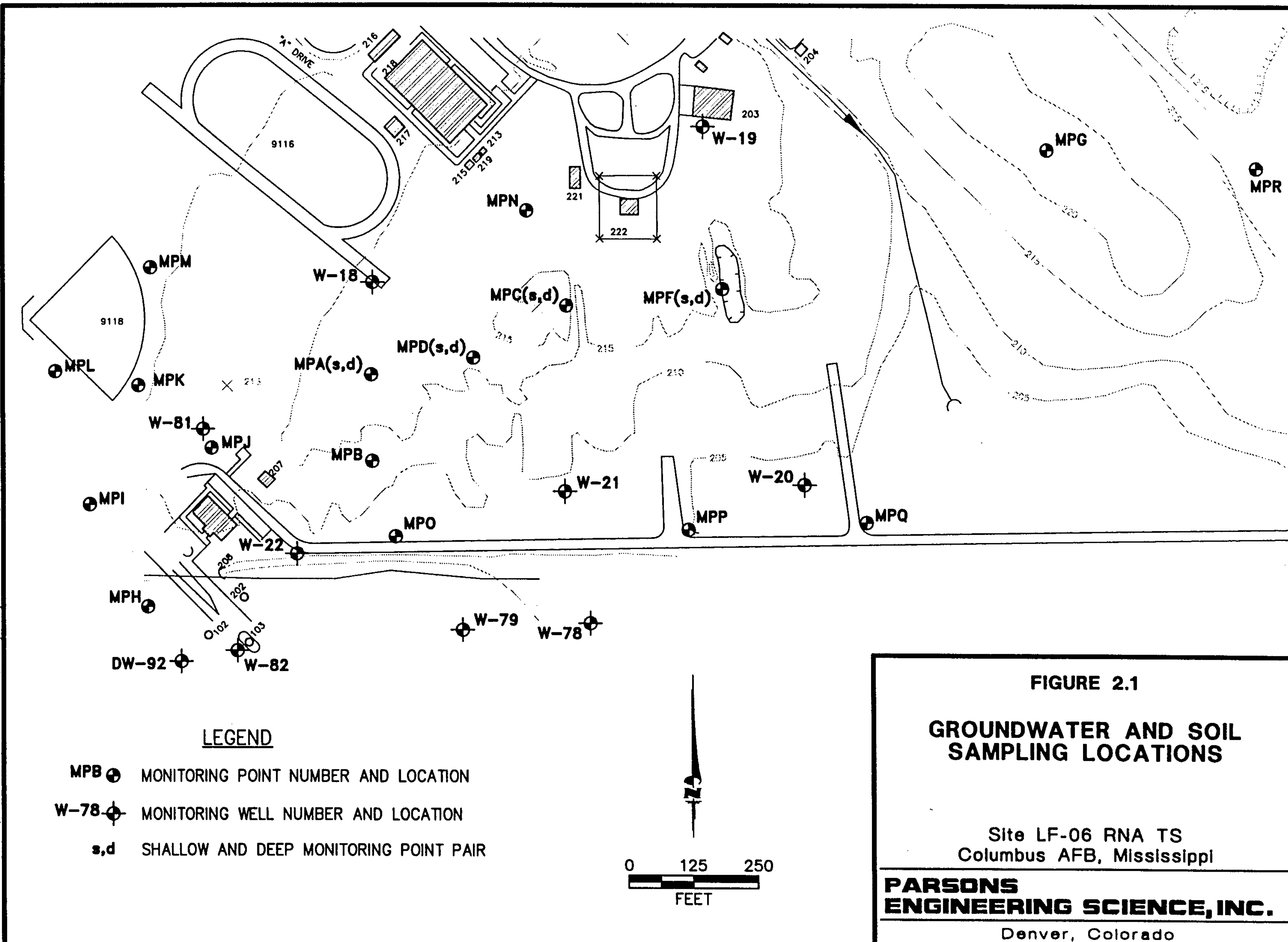

FIGURE 2.1

GROUNDWATER AND SOIL SAMPLING LOCATIONS

Site LF-06 RNA TS
Columbus AFB, Mississippi

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Denver, Colorado

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TABLE 2.1
MONITORING POINT AND MONITORING WELL COMPLETION DATA
LF-06 RNA TS
COLUMBUS AFB, MISSISSIPPI

Well Identification	Installation Date	Well Diameter (inches)	Total Depth Measured (Feet toc)	Screened Interval (feet bgs)[a]	Survey Northing (State Plane)[b]	Survey Easting (State Plane)	Elevation of Reference Point for Measurements (feet msl)[c]	Elevation Datum
Monitoring Points								
MPA(s)	11/12/96	0.5		10.5-15.5	1439839.5921	621166.0172	216.7	Top of PVC Casing
MPA(d)	11/17/96	0.375		30.7-31.2	1439839.5921	621166.0172	217.7	Top of Tubing
MPB	11/9/96	0.5		7-12	1439643.0514	621168.3734	211.9	Top of PVC Casing
MPC(s)	11/16/96	0.5		20-23	1440002.2419	621620.4489	218.7	Top of PVC Casing
MPC(d)	11/16/96	0.375		31.1-31.6	1440002.2419	621620.4489	219.9	Top of Tubing
MPD(s)	11/16/96	0.5		15-18	1439880.2070	621404.3915	216.5	Top of PVC Casing
MPD(d)	11/16/96	0.375		31.1-31.6	1439880.2070	621404.3915	217.6	Top of Tubing
MPF(s)	11/15/96	0.5		11-14	1440040.7906	621987.1107	215.0	Top of PVC Casing
MPF(d)	11/15/96	0.375		30.5-31	1440040.7906	621987.1107	216.0	Top of Tubing
MPG	11/13/96	0.5		15-18	1440365.4145	622741.1228	219.3	Top of PVC Casing
MPH	11/13/96	0.5		9-14	1439306.1636	620642.9713	208.6	Top of PVC Casing
MPI	11/15/96	0.5		23-26	1439541.5590	620508.3941	206.7	Top of PVC Casing
MPJ	11/12/96	0.375		18.5-19	1439669.5326	620792.4084	213.4	Top of PVC Casing
MPK	11/14/96	0.5		15-18	1439815.8194	620620.2490	209.3	Top of PVC Casing
MPL	11/14/96	0.5		12-17	1439848.2203	620429.6530	206.6	Top of PVC Casing
MPM	11/13/97	0.5		15-18	1440089.8564	620650.4350	208.5	Top of PVC Casing
MPN	11/16/96	0.5		24-27	1440221.4005	621528.6319	219.1	Top of PVC Casing
MPO	11/13/96	0.5		9-14	1439452.8637	621222.0761	203.6	Top of PVC Casing
MPP	11/12/96	0.5		8-14	1439472.5487	621894.2265	204.9	Top of PVC Casing
MPQ	11/12/96	0.5		8-14	1439501.9037	622302.9421	204.3	Top of PVC Casing
MPR	11/14/96	0.5		13-16	1440344.4043	623216.8753	212.7	Top of PVC Casing
Monitoring Wells								
W18	2/29/88	2.0		21-31	1440056.0402	621169.7223	215.6	Top of PVC Casing
W19	3/1/88	2.0		20.5-30.5	1440413.5[f]	621948.89[f]	219.0[d]	Top of PVC Casing
W20	3/1/88	2.0		13-23	1439588.3460	622175.2869	205.6	Top of PVC Casing
W21	2/28/88	2.0		18-28	1439564.86[f]	621616.88[f]	207.2[d]	Top of PVC Casing
W22	3/1/88	2.0		11.5-21.5	1439427.1258	620992.4735	208.7	Top of PVC Casing
W78	5/25/89	2.0		10-20	1439168.24[f]	621658.51[f]	206.8[d]	Top of PVC Casing
W79	5/26/89	2.0		10-20	1439177.54[f]	621310.63[f]	208.0[d]	Top of PVC Casing
W81	11/4/94	2.0		17-27	1439155.87[f]	620830.78[f]	212.2[e]	Top of PVC Casing
W82	11/5/94	2.0		15-25	1439807.23[f]	620810.93[f]	207.2[e]	Top of PVC Casing

a/ Feet bgs = feet below ground surface.
b/ State Plane = State of Mississippi Plane Coordinate System.
c/ Feet msl = feet above mean sea level.
d/ Reference point elevation determined by adding 0.3 ft to survey data reported by CH2M Hill in 1989.
e/ Reference point elevation obtained from well instalation records produced by CH2M Hill in November, 1994.
f/ Easting and northing survey coordinates obtained from BCM/Smith survey, 1996

followed by a final rinse with deionized water. Precautions were taken to minimize impact to the areas surrounding decontamination operations. All decontamination activities were conducted in a manner so that the excess water was controlled and not allowed to flow into any open borehole.

All decontamination fluids were collected and contained in 55-gallon drums. The contents of the drums were inspected prior to release to the Base sanitary sewer. If the water had exhibited a sheen or odor of any kind, the water would have been transported to a temporary holding facility designated by the Base. None of the water exhibited signs of contamination, and therefore, Base Civil Engineering was notified and the water was released to the sanitary sewer.

2.1.1.3 Drilling and Soil Sampling

Drilling was accomplished using the Geoprobe® direct-push technology. The boreholes were sampled continuously to the total depth of the borehole. Where two points were installed adjacent to each other (i.e., nested), only the deeper point was logged and sampled. The Geoprobe®-collected soil samples were obtained using 4 foot by 1.5 inch inside diameter (ID) and 2 foot by 1-1/16-inch ID sampling devices. The large sampler was used for the initial 10 feet of soil. The smaller sampler was then used for the remainder of the borehole in an attempt to minimize the smearing of surface contamination into deeper portions of the borehole. A probe-drive sampler attached to the leading end of the probe rods serves as both the driving point and the sample collection device. To collect a soil sample, the sampler was pushed or driven to the desired sampling depth, the drive point was retracted to open the sampling barrel, and the sampler was subsequently pushed into the undisturbed soils. The soil cores were retained within a clear acetate liner inside the sampling barrel. The probe rods were then retracted, bringing the sampling device to the surface. The soil sample was then extruded from the liners for visual lithologic logging, photoionization detector (PID) headspace screening, and collection for chemical testing at an analytical laboratory.

The Parsons ES field geologist observed drilling and monitoring point installation activities and maintained a detailed descriptive log of recovered subsurface materials. Final geologic borehole logs are presented in Appendix A. These logs contain:

- Sampled interval (top and bottom depth);
- Presence or absence of contamination based on odor, staining, and/or PID readings;
- Soil description, including color, major textural constituents, minor constituents, relative moisture content, plasticity of fines, cohesiveness, grain size, structure or stratification, and any other significant observations; and
- Lithologic contacts, with the depth to contacts and/or significant textural changes recorded to the nearest 0.1 foot.

Bags containing soil samples collected for the headspace screening procedure were quickly sealed and stored for 15 minutes or longer at the ambient temperature. Semiquantitative measurements were made by puncturing the bag seal with the PID probe and reading the concentration of the headspace gases. The PID relates the concentration of total volatile organic compounds (VOCs) in the sample to an isobutylene calibration standard. The PID also was used to monitor for VOCs in the worker breathing zone.

Soil samples were collected from boreholes MPF, MPJ, and MPL. At MPF and MPJ, samples submitted for laboratory analysis were from the intervals giving the highest PID headspace readings. Where no elevated PID headspace readings were encountered (MPL), a sample was collected from immediately above the water table. Analytical sample containers and appropriate container lids were provided by Envirotech, Inc. Personnel from Parsons ES performed the soil sampling.

The sample containers were filled completely to minimize headspace. The containers were sealed with Teflon® tape and lids were placed over the tape and tightly closed. A

sample label was attached to the container side, and the following information was legibly and indelibly written on the label:

- Sample identification;
- Requested analysis;
- Sample depth;
- Sampling date; and,
- Sample collector's initials.

After the sample containers were sealed and labeled, they were placed in a cooler with ice and held for transport to the laboratory.

2.1.2 Temporary Monitoring Point Installation

Temporary groundwater monitoring points were installed in 21 boreholes at 17 locations under this program (Figure 2.1). Detailed monitoring point installation procedures are described in the following paragraphs.

2.1.2.1 Monitoring Point Materials Decontamination

Monitoring point completion materials were inspected by the field geologist and determined to be clean and acceptable prior to use. All monitoring point completion materials were factory sealed in plastic wrap. Pre-packaged casing, sand, and bentonite were used in well construction, and were inspected for possible external contamination before use. Materials that could not be cleaned to the satisfaction of the field geologist were not used.

2.1.2.2 Monitoring Point Casing and Screen

Two designs were used to construct monitoring points. The majority of the shallow monitoring points were constructed of Schedule 40 polyvinyl chloride (PVC) riser pipe

connected to factory-slotted PVC screens having an ID of 0.5 inch. The PVC points were placed wherever formation soils did not collapse into the borehole after the Geoprobe® rods were extracted. In the event that collapsing soils prevented the placement of the PVC screen after the extraction of the soil probe the monitoring points were constructed using Teflon®-lined, high-density polyethylene (HDPE) tubing threaded through the center of the drive rods. The tubing was attached to a double-woven wire screen, which in turn was threaded into a dedicated stainless steel (SS) drive point/implant anchor that remained in place after the drive rods were removed. All PVC casing and screen sections on the shallow monitoring points were flush threaded, and glued joints were not used. The riser pipe at each PVC monitoring point was fitted with a PVC top cap, and an aluminum drive point was inserted into the bottoms of the PVC screens.

The majority of the deep monitoring points were constructed using the SS screens and Teflon®-lined HDPE tubing described above. The riser tubing for deep monitoring points extended to the surface, and the bottom of the SS mesh screen was threaded to the dedicated SS drive point/implant anchor that remained in place after the drive rods were removed.

Monitoring point screens constructed of PVC were 3 to 6 feet long and factory slotted with 0.010-inch openings. Monitoring point screens constructed of SS were 0.5 foot in length with pore openings of 0.037 inch. Shallow points were screened near the water table. Well screen positions were selected by the field hydrogeologist after consideration was given to the geology and hydraulic characteristics of the stratum in which the wells were screened.

Monitoring point construction details were noted on a monitoring point installation record and are summarized in Table 2.1. This information became part of the permanent field record for the site. Monitoring point installation records for LF-06 are presented in Appendix A.

2.1.2.3 Sand Filter Pack and Annular Sealant

Placement of a filter pack around the monitoring point casing screens was not possible as a result of the collapse of the sand borehole walls. Therefore, the temporary monitoring points were naturally sand-packed with the formation materials. Due to the sandy nature of the formation materials, well development and purging activities were accomplished without difficulty. A filter pack seal of sodium bentonite chips or grout was placed in the portion of the hole which remained open following collapse of the sandy borehole walls. This was typically the top 2 to 3 feet of the borehole.

2.1.2.4 Protective Cover

For all temporary monitoring points, protective 8-inch-diameter flush-mount casings were set into a 2-foot-square concrete pad to a depth of 0.5 to 1.0 foot bgs. The casings were cemented in place with the bottom anchored in a 6-inch thick gravel pad in order to facilitate drainage of excess storm water penetrating the protective casing. The tops of the covers were placed approximately at ground surface. Well identifications were permanently inscribed on the well casing and protective cover.

2.1.3 Monitoring Point Development

Prior to sampling, temporary monitoring points were developed. Typically, development removes sediment from inside the well casing and flushes fines, cuttings, and drilling fluids from the sand pack and the portion of the formation adjacent to the well screen. Use of the Geoprobe® system to place monitoring points eliminates cuttings and drilling fluids. As a result, development of monitoring points is primarily intended to minimize the amount of fine sediment that might accumulate in the casing.

Monitoring point development was accomplished using a peristaltic pump with dedicated HDPE and silicon tubing. For monitoring points constructed from 0.5 inch PVC, HDPE tubing was inserted into the well. A length of silicon tubing was attached to the end of the HDPE tubing and directed through the peristaltic pump head. For monitoring points

constructed from Teflon® lined tubing, HDPE tubing was not required. Instead, the silicon tubing was attached to the Teflon®-lined tubing comprising the monitoring point casing, and directed through the peristaltic pump head. Development was continued until a minimum of 10 casing volumes of water were removed from the point and the groundwater pH, temperature, conductivity, and dissolved oxygen concentrations had stabilized.

2.2 GROUNDWATER SAMPLING

This section describes the procedures used for collecting groundwater samples. In order to maintain a high degree of quality control (QC) during this sampling event, the procedures described in the site work plan (Parsons ES, 1996) and summarized in this section were followed.

Groundwater sampling occurred between November 13 and 19, 1996, and consisted of collecting groundwater samples from 20 newly installed temporary monitoring points and 9 existing monitoring wells (Figure 2.1). A groundwater sample could not be obtained from the newly installed monitoring point MPD(s), because it was purged dry and never recovered. Groundwater sampling forms were used to document the specific details of the sampling event for each location. Groundwater samples were analyzed for the parameters listed in Table 2.2. Groundwater samples were analyzed by Parsons ES personnel in the field for alkalinity, ammonia, dissolved oxygen (DO), total and ferrous iron, conductivity, free carbon dioxide, pH, reduction/oxidation (redox) potential, salinity, soluble manganese, sulfide, sulfate, nitrite, nitrate, chloride, and temperature. Laboratory analyses for alkalinity, cnloride, methane, nitrate and nitrite, sulfate, purgeable aromatic hydrocarbons, total hydrocarbons, total organic carbon, and VOCs were performed by Evergreen Analytical, Inc.

2.2.1 Preparation for Sampling

All equipment used for sampling was assembled and properly cleaned and calibrated (if required) prior to arriving in the field. In addition, all record-keeping materials were

TABLE 2.2
ANALYTICAL PROTOCOLS FOR GROUNDWATER AND SOIL SAMPLES
LF-06 RNA TS
COLUMBUS AFB, MISSISSIPPI

MATRIX Analyte	METHOD	FIELD (F) OR FIXED-BASE (L) ANALYTICAL LABORATORY
WATER		
Chloride	Colorimetric, Hach Method 1440-01 (or similar)	F
Total Iron	Colorimetric, Hach Method 8008 (or similar)	F
Ferrous Iron (Fe+2)	Colorimetric, Hach Method 8146 (or similar)	F
Ferric Iron (Fe+3)	Difference between total and ferrous iron	F
Manganese	Direct-reading meter	F
Salinity	Direct-reading meter	F
Sulfide	Colorimetric, Hach Method 8131 (or similar)	F
Sulfate	Colorimetric, Hach Method 8051 (or similar)	F
Nitrate	Titrimetric, Hach Method 8039 (or similar)	F
Nitrite	Titrimetric, Hach Method 8507 (or similar)	F
Redox Potential	A2580B, direct-reading meter	F
Oxygen	Direct-reading meter	F
pH	E150.1/SW9040, direct-reading meter	F
Conductivity	E120.1/SW9050, direct-reading meter	F
Temperature	E170.1	F
Alkalinity (Carbonate [CO3-2] and Bicarbonate [HCO3-1])	Titrimetric, Hach Method 8221 (or similar)	F
Carbon Dioxide	CHEMetrics Method 4500	F
Nitrate	E300 or SW9056	L
Nitrite	E300 or SW9056	L
Chloride	E300 or SW9056	L
Sulfate	E300 or SW9056	L
Alkalinity	E150.1	L
Methane	EAL-SOP-GC404	L
Total Organic Carbon	SW9060	L
Aromatic Hydrocarbons (Including Trimethylbenzenes and Tetramethylbenzene)	SW8020A	L
Total Hydrocarbons	SW8015	L
Volatile Organic Compounds	SW8240B	L
SOIL		
Total Organic Carbon	SW9060	L
Moisture	ASTM D-2216	L
Aromatic Hydrocarbons	SW8020	L
Total Hydrocarbons	SW8015	L
Volatile Organic Compounds	SW8240B	L

gathered prior to leaving the office. Special care was taken to prevent contamination of the groundwater and extracted samples through cross contamination from improperly cleaned equipment; therefore, water level indicators and sampling equipment were thoroughly cleaned before and after field use and between uses at different sampling locations. In addition, a clean pair of new, disposable gloves was worn each time a different well/point was sampled.

All portions of sampling and test equipment that contacted the sample were thoroughly cleaned before use. This equipment included the water level probe and cable, equipment for measuring onsite groundwater chemical parameters, and other equipment that contacted the samples. All peristaltic pump tubing was dedicated to each sampling location. The following cleaning protocol was used:

- Cleaned with potable water and phosphate-free laboratory detergent;
- Rinsed with potable water;
- Rinsed with isopropyl alcohol;
- Rinsed with distilled or deionized water;
- Air dried prior to use.

Any deviations from these procedures were documented in the field scientist's field notebook and on the groundwater sampling form. Decontamination fluids were contained as described in Section 2.1.1.2.

As required, field analytical equipment was calibrated according to the manufacturers' specifications prior to field use. This requirement applied specifically to onsite chemical measurements of DO, conductivity, and pH.

Prior to removing any water from the existing monitoring wells, the static water level was measured. An electrical water level probe was used to measure the depth to

groundwater below the well datum to the nearest 0.01 foot. After measurement of the static water level, the water level probe was lowered to the bottom of the well for measurement of total well depth (recorded to the nearest 0.01 foot). Based on these measurements, the volume of water to be purged from the monitoring wells was calculated. For the temporary monitoring points, the volume of water to be purged was estimated from the total depth of the monitoring point as recorded in the field notes.

2.2.2 Well/Point Purging and Sample Collection

A peristaltic pump was used for well evacuation. For monitoring wells, both dedicated HDPE and silicon tubing were used. For monitoring points, the same dedicated tubing arrangement described for development (Section 2.1.3) was used. Purging consisted of removing at least three times the calculated casing volume prior to sample collection. Once three casing volumes were removed from the well, purging continued until the DO, temperature, and conductivity readings had stabilized. Purge waters generated during the site characterization event were placed in 5-gallon buckets and transported to the on-site 1,200-gallon waste water tank.

The same peristaltic pump and dedicated tubing arrangement was used to extract groundwater samples from each well or Geoprobe® point. The groundwater sample was transferred directly into the appropriate sample container. The water was carefully poured down the inner walls of the sample bottle to minimize aeration of the sample. Sample bottles for BTEX, total fuel carbon, and VOC analyses were filled so that there was no headspace or air bubbles within the container. Table 2.2 lists the analyses performed on collected groundwater samples.

2.2.3 Onsite Chemical Parameter Measurement

Measurement of DO, pH, specific conductance, redox potential, and temperature was performed at the sampling location at the time of sample collection. All other field

parameters were measured onsite by Parsons ES personnel at their temporary laboratory immediately following sample collection.

DO measurements were taken using a YSI-55 DO meter in a flow-through cell at the outlet of the peristaltic pump. DO concentrations were recorded after the readings stabilized, and in all cases represent the lowest DO concentration observed.

Because the specific conductance, pH, redox potential, and temperature of groundwater can change significantly within a short time following sample acquisition, parameters were measured in the same flow-through cell used for DO measurements. Conductivity and temperature were measured using an Extech® meter. Redox potential and pH were measured using an Orion® 250A meter.

An onsite laboratory staffed by Parsons ES personnel was used to analyze for several indicator parameters in groundwater samples collected from pre-existing monitoring wells and newly installed monitoring points (Table 2.1). A Hach® DR/700 colorimeter was used to measure ferrous iron (Fe^{+2}), total iron (Fe), manganese (Mn^{+2}), and sulfide (S^{2-}). Titrations using Hach® reagents were conducted to measure alkalinity [as milligrams per liter (mg/L) calcium carbonate ($CaCO_3$)] and chloride (Cl^-); and CHEMtric® color tests were used to measure ammonia (NH_3) and carbon dioxide (CO_2). These analyses were completed for each groundwater sample after all sample containers had been filled. The sample to be analyzed was poured into a clean glass container, capped, and transported to the Parsons ES on-Base laboratory for analysis. Special care was taken to avoid aerating the sample in the sample container, which could influence the concentration of reduced species. The field holding time for each sample did not exceed 0.5 hour. Care was taken to minimize sample temperature changes and exposure to sunlight. Concentrations of these indicator parameters were not measured in soil samples.

2.2.4 Sample Handling

Evergreen Analytical, Inc. provided appropriate pre-preserved sample containers. Samples were delivered to the Parsons ES temporary laboratory within minutes of sample collection. Samples for those analyses not performed by the temporary laboratory were appropriately packaged and shipped with ice to Evergreen Analytical, Inc. in Wheat Ridge, Colorado for analysis. The associated chain-of-custody documentation for the fixed-base laboratory was the responsibility of the Parsons ES field personnel.

The sample containers were filled as described in Sections 2.2.3, and the container lids were tightly closed. The sample label was firmly attached to the container side, and the following information was legibly and indelibly written on the label:

- Facility name;
- Sample identification;
- Requested analysis;
- Sample type (groundwater);
- Sampling date;
- Sampling time;
- Preservatives added; and
- Sample collector's initials.

2.3 AQUIFER TESTING

Slug tests were performed in November 1996 in wells W18, W19, W22, W79, W81, and W82 (Figure 2.1) to provide estimates for the hydraulic conductivity of the shallow saturated zone in the vicinity of LF-06. Slug tests are single-well hydraulic tests used to estimate the hydraulic conductivity of an aquifer in the immediate vicinity of the tested

well. Slug testing can be performed using either a rising head or a falling head test. Both rising head and falling head tests were performed at this site. Detailed slug testing procedures are presented in the *Technical Protocol for Implementing Intrinsic Remediation with Long-Term Monitoring for Natural Attenuation of Fuel Contamination Dissolved in Groundwater* (Wiedemeier *et al.*, 1995).

Data obtained during slug testing were analyzed using the computer program AQTESOLV® (Geraghty & Miller, Inc., 1994) and the methods of Bouwer and Rice (1976) and Bouwer (1989) for unconfined conditions. The results of slug testing are presented in Section 3.3 and Appendix A.

2.4 SURVEYING

After completion of field work in November 1996, the locations and elevations of all new monitoring wells were surveyed by CH2M Hill, a company licensed to perform land surveying. The horizontal locations and elevations of the measurement datum (top of well casing or top of outer casing) were measured relative to existing control points referenced to the Mississippi State Plane coordinate system. Horizontal locations were surveyed to the nearest 0.5 foot. Measurement datum and ground surface elevations were surveyed to the nearest 0.1 foot and referenced to mean sea level (msl) elevation. Survey data are presented in Table 2.1 and Appendix A. The locations of Geoprobe® grab samples were estimated by measuring the distance between adjacent monitoring wells and surface references.

SECTION 3

PHYSICAL CHARACTERISTICS OF THE STUDY AREA

This section describes the physical characteristics of Site LF-06 as determined from data collected by Parsons ES in November 1996, in conjunction with data documented in previous reports on LF-06 and Columbus AFB (CH2M Hill, 1989 and 1995; Spencer, 1996a and 1996b). Investigative techniques used by Parsons ES to determine the physical characteristics of the site are discussed in Section 2.

3.1 SURFACE FEATURES

3.1.1 Topography

Columbus AFB is located in northeastern Mississippi and lies in the Tombigbee and Tennessee River Hills physiographic district of the Gulf Coastal Plain (CH2M Hill, 1989). This area is characterized by a low, relatively flat terrain. Land surface elevations in the vicinity of Columbus AFB range from 180 to 220 feet above msl. A topographic map of Columbus AFB is presented as Figure 3.1.

3.1.2 Surface Water Hydrology

Columbus AFB is bounded to the west and north by the Tombigbee River and the Buttahatchie River, respectively. Surface water runoff from the Base primarily drains into the Tombigbee River, with exception of the northeastern portion of the Base, which drains into the Buttahatchie River. The northwestern corner of the Base lies within the 100-year floodplain of both rivers and occasionally floods (CH2M Hill, 1995).

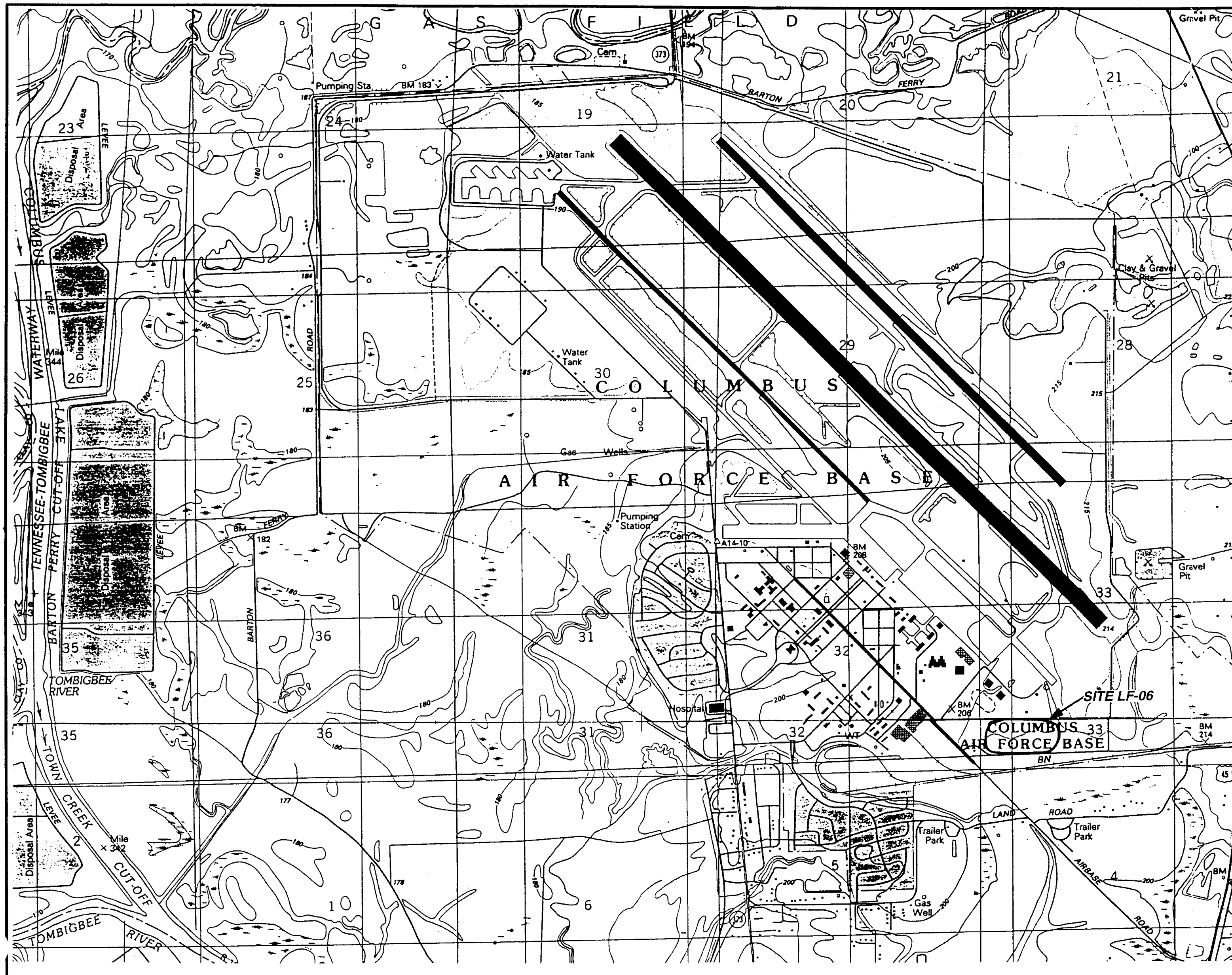

FIGURE 3.1

TOPOGRAPHIC MAP OF COLUMBUS AFB AREA

Site LF-06 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

Source: Columbus North, Hamilton Mississippi, 1987.

3.2 REGIONAL GEOLOGY AND HYDROGEOLOGY

The shallow subsurface geology in northeastern Mississippi consists of Cretaceous Gulf Coastal Plain sediments overlain by Quaternary alluvial sediments. The Cretaceous coastal plain sediments unconformably overlie an irregular surface of Paleozoic basement rocks (CH2M Hill, 1989).

Unconsolidated sediments comprise the upper 40 feet of subsurface geology at the Base. These sediments are alluvial and lower terrace deposits composed of sand and gravel overlying clay and sandy clay. Upper units of the Cretaceous Coastal Plain sediments consist of sand, silt, gravel, clay, and calcareous marine strata. Lower units of the Cretaceous Series comprise a southward-thickening wedge of sand, clay, shale, gravel, and calcareous strata of marine origin (CH2M Hill, 1989). The upper units of the Coastal Plain sediments that crop out in the vicinity of Columbus AFB lie on the eastern flank of the Mississippian Embayment, a southward-plunging structural syncline. The embayment is essentially a large trough that subsided as Cretaceous sediments were deposited in a shallow inland sea. Stratigraphic units in the vicinity of the Base slope toward the axis of the embayment syncline, though the southwest dip of strata is less than 20 feet per mile (CH2M Hill, 1989). This structural control has resulted in north-south trending outcrop belts in areas surrounding the Base. Paleozoic basement rocks crop out only in the northeast corner of the state as Devonian and Mississippian sedimentary units.

Sandy Cretaceous sediments are the most important source of groundwater in Lowndes County. Recharge to these aquifers occurs mainly by downward infiltration of rainwater in outcrop areas (CH2M Hill, 1989). Two major hydrogeologic units are present in Lowndes County: a surficial, unconfined alluvial aquifer and the deeper, confined to semi-confined Eutaw Aquifer.

The surficial aquifer is part of the Upper Eutaw Formation, and includes the Tombigbee sand member when present. The surficial aquifer averages less than 40 feet in thickness and consists of alluvial sand, silty clay, and gravel deposits. Previous studies show the

regional hydraulic conductivity of the surficial aquifer to vary between 3.8 and 570 feet per day (ft/day) (CH2M Hill, 1989).

The semi-confining layer that separates the upper, surficial aquifer and the deeper, confined to semi-confined Eutaw Aquifer is estimated to be approximately 5 to 90 feet thick across the Base (CH2M Hill, 1995). This layer primarily consists of low permeability silt and clay interlayered with sand and has a hydraulic conductivity which ranges from 1.9×10^{-2} ft/day to 1.7×10^{-4} ft/day (CH2M Hill, 1989). Eutaw sediments of the confining layer have been identified as greenish-gray, finely laminated clay in the vicinity of the Base (Spencer, 1996a).

The confined to semi-confined Eutaw Aquifer consists of both Eutaw Formation and Tuscaloosa Group sediments. The confined Eutaw Aquifer is about 150 feet thick in the vicinity of the Base and receives most of its recharge north of the Base at the formation outcrop (CH2M Hill, 1989). The regional groundwater flow direction within the Eutaw Aquifer in the vicinity of the Base is toward the west-southwest, coinciding with the regional dip of the Formation. The Eutaw Aquifer consists of tan to brown sand (called Tuscaloosa sand) with coarse gravel and lenses of clay (CH2M Hill, 1989) and is generally identified by the presence of glauconitic sediments (Spencer, 1996a). Previous studies show the hydraulic conductivity of the Eutaw Aquifer within the Base to vary between 2 ft/day and 30 ft/day, and to average 7 ft/day (Spencer, 1996a). Beneath the Eutaw Formation is the Tuscaloosa Group, which consists of coarse sand and gravel deposits and is also considered part of the Eutaw Aquifer. Columbus AFB operates three potable water supply wells completed in the Tuscaloosa Group, at depths of approximately 400 feet bgs (CH2M Hill, 1995).

Shallow groundwater in the vicinity of the Base is typically present within the surficial aquifer at approximately 15 feet bgs. However, it is reported that groundwater elevations in the surficial aquifer may vary seasonally by as much as 10 feet, depending on rainfall patterns (CH2M Hill, 1989). Aquifer recharge occurs by downward infiltration of

rainwater through the relatively permeable alluvial deposits. Shallow groundwater within the northern section of the Base generally flows to the northwest toward the Buttahatchie River, while groundwater within the southern half of the Base, generally flows to the west-southwest toward the Tombigbee River (CH2M Hill, 1995; Spencer, 1996b).

3.3 SITE GEOLOGY AND HYDROGEOLOGY

Characterization of the subsurface sediments has been the objective of several investigations; the site geology and hydrogeology descriptions presented below were principally derived from a previous Site Inspection Report (CH2M Hill, 1995) and the current investigation. There are currently nine groundwater monitoring wells associated with LF-06 (Figure 3.2). As part of the current investigation, twenty-one monitoring points were installed at seventeen locations using a Geoprobe®.

3.3.1 Lithology and Stratigraphic Relationships

Surface sediments at the site primarily consist of the upper terrace Prentiss-Rosella-Steens Association, which is composed of sand, silt, and clay loams. The sediments range from 0 to 18 feet in thickness at the site, and overlie approximately 40 feet of lower terrace and alluvial deposits composed of alluvial sand and gravel. In turn, the lower terrace and alluvial deposits overlie coastal plain clay and sandy clay deposits.

To illustrate these stratigraphic relationships, hydrogeologic sections have been developed from subsurface data derived from logs of previously installed monitoring wells and from the November 1996 Geoprobe® investigation. Figure 3.2 shows the locations of these sections. Figure 3.3 presents the hydrogeologic section A-A', which is oriented approximately parallel to the direction of groundwater flow. Figure 3.4 presents the hydrogeologic section B-B', which is oriented approximately perpendicular to the direction of groundwater flow. In general, hydrogeologic sections A-A' and B-B' depict 0 to 18 feet

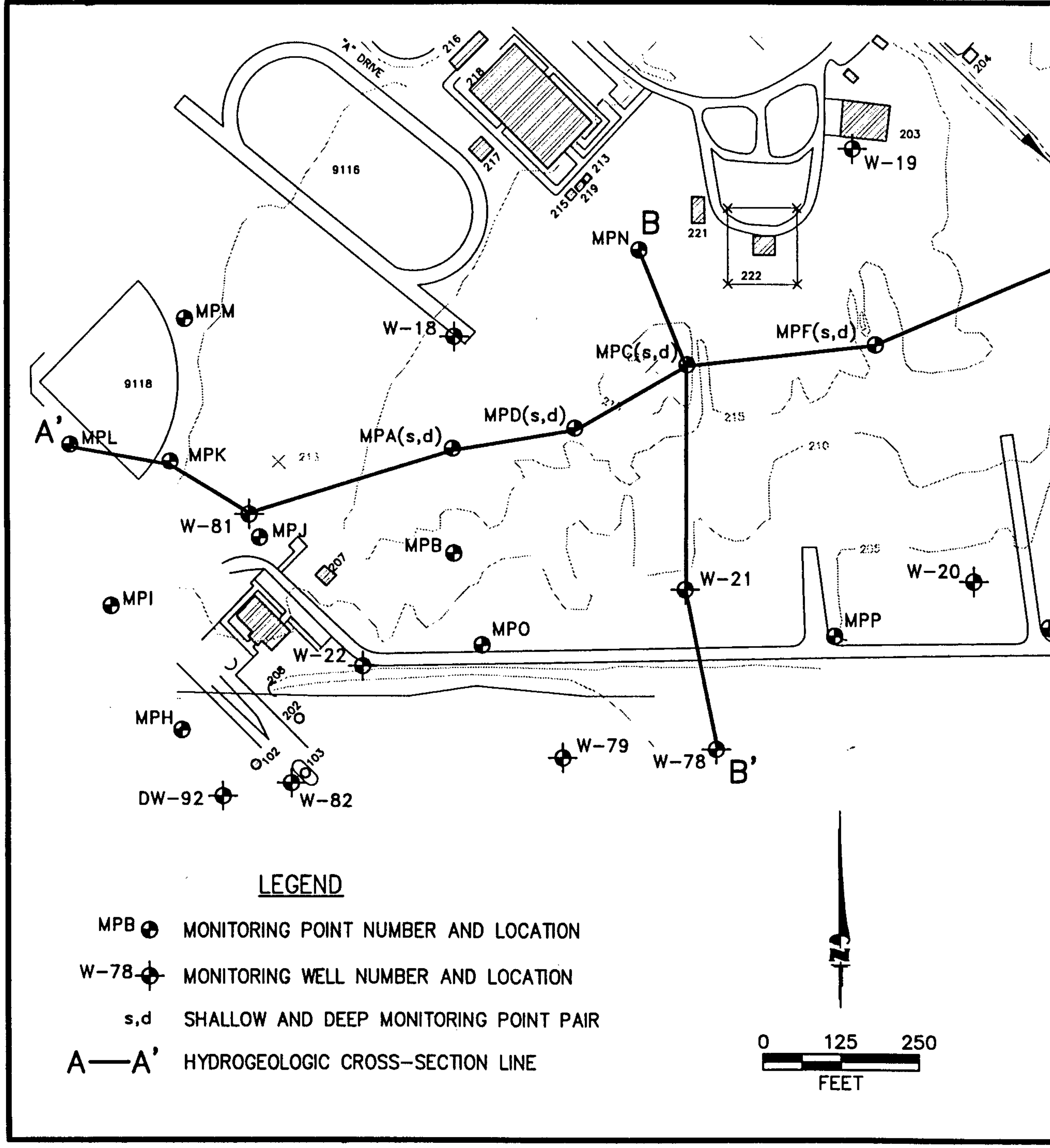

FIGURE 3.2

LOCATION OF HYDROGEOLOGIC CROSS-SECTIONS

Site LF-06 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

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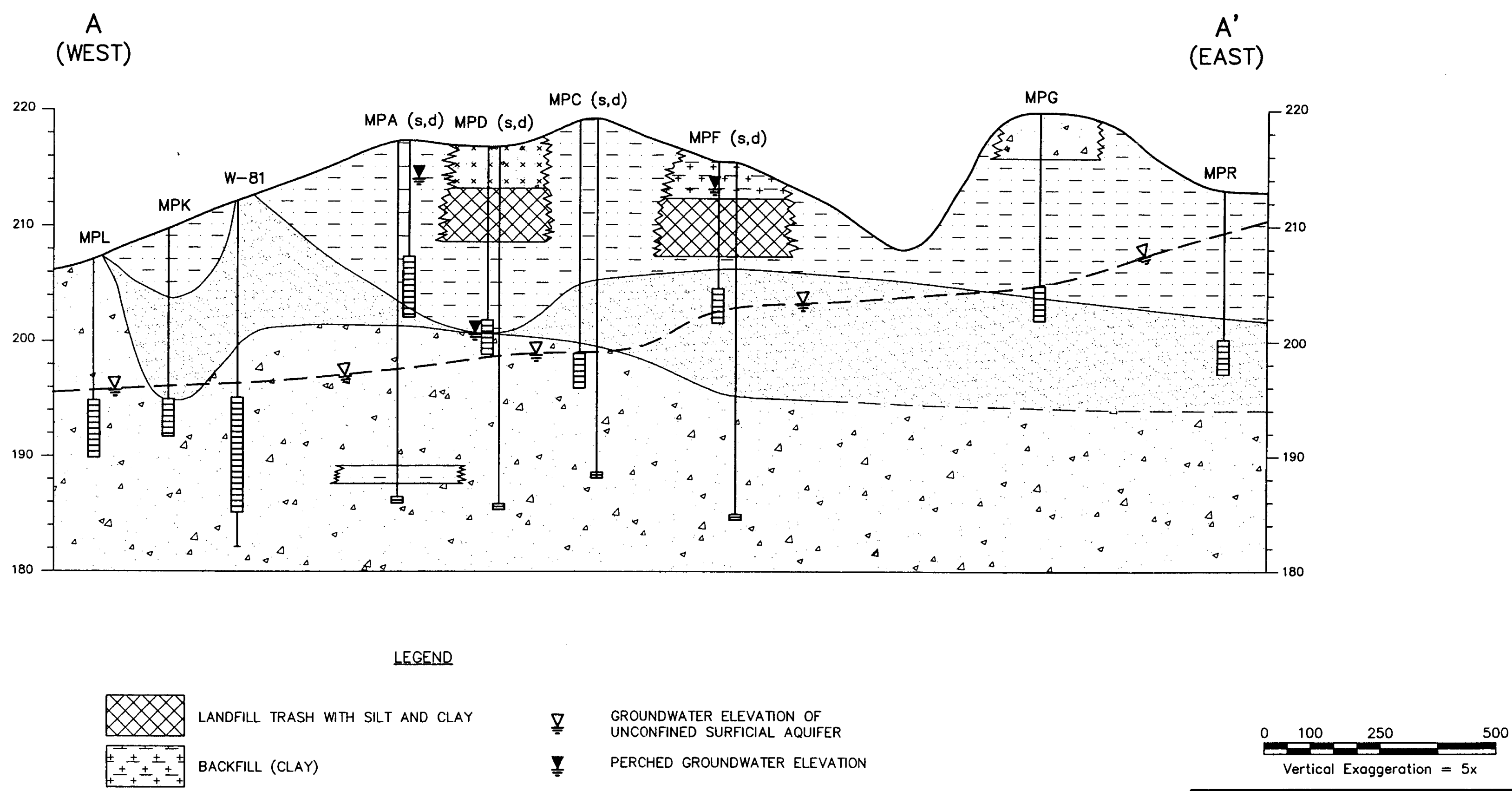

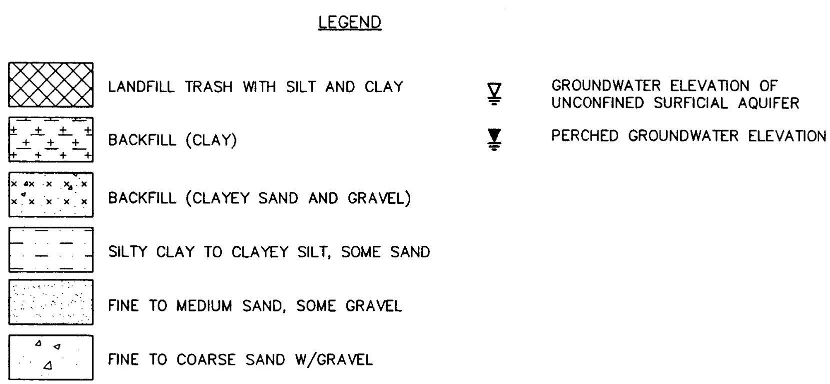

FIGURE 3.3

HYDROGEOLOGIC CROSS-SECTION A-A'

Site LF-06 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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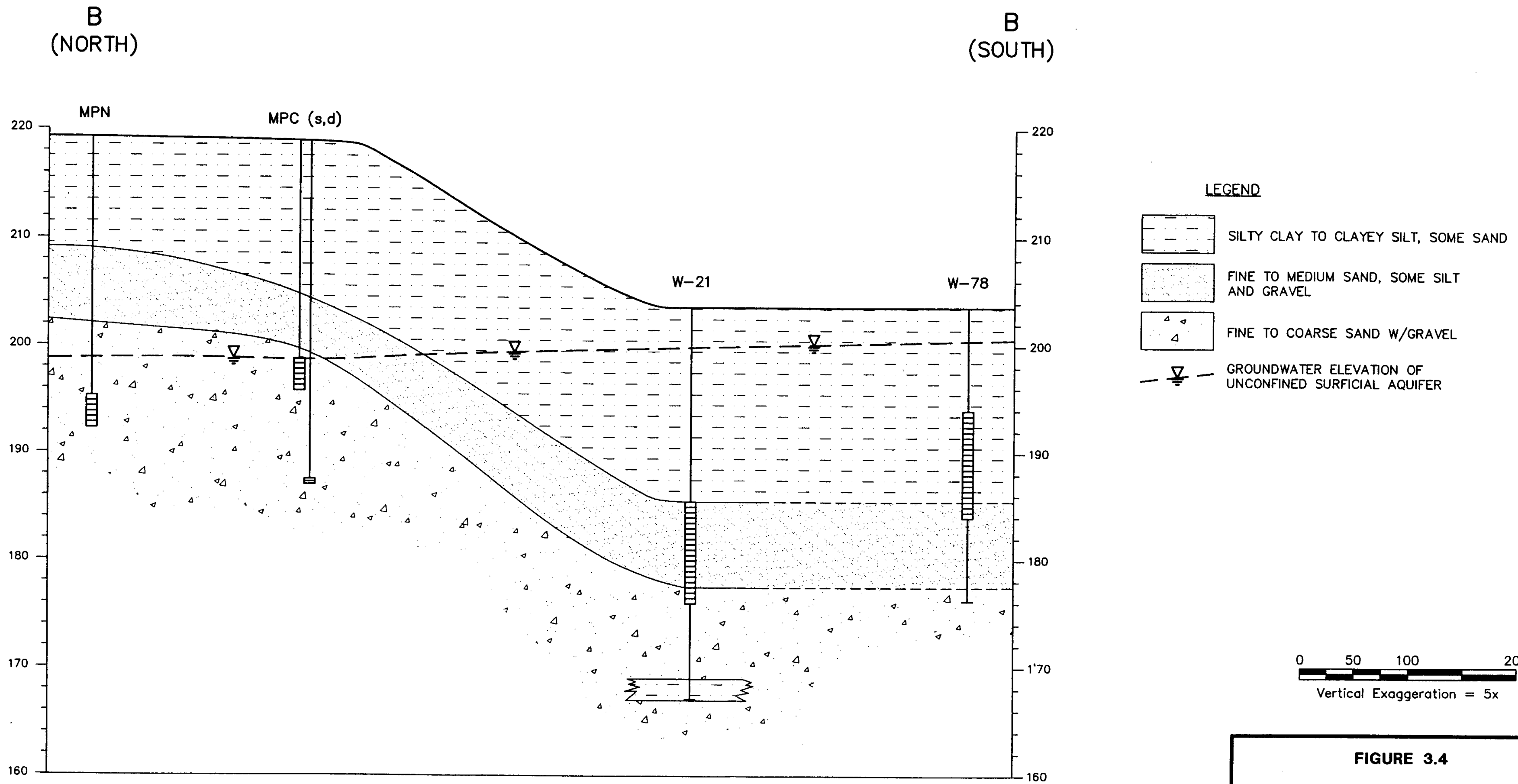

FIGURE 3.4

HYDROGEOLOGIC CROSS-SECTION B-B'

Site LF-06 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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of silty and clayey soils overlying 1 to 10 feet of fine to medium sand, which in turn, overlie fine to coarse sand with gravel.

3.3.2 Groundwater Hydraulics

The water table at the site is located in both the silty and clayey soils and the sandy Quaternary sediments of the unconfined surficial aquifer. Depth to groundwater is approximately 5 to 21 feet bgs across the site. However, perched water occurs in wells screened above the shallow potentiometric surface, possibly resulting from the presence of landfill trash. Perched water occurs in wells MPA(s), MPB, MPD(s), MPF(s), MPH, and MPJ. These perched levels range from approximately 2.5 ft to 16.5 ft above the groundwater surface measured by deeper wells (Figure 3.3). A summary of groundwater measurements from November 1996 is presented in Table 3.1. The reference point elevations measured in November 1996 for wells W-18, W-20, and W-22 were 0.3 feet higher than the elevations measured for these wells in 1989. Because reference point elevations for wells W-19, W-21, W-78, and W-79 were not surveyed during the November 1996 field effort, these elevations were estimated by adding a bias of 0.3 ft to top-of-casing elevations from a survey conducted by CH2M Hill in 1989 to align them with the reference points surveyed in 1996. Reference point elevations for wells W-81 and W-82 were obtained from a survey corresponding with their installation in 1994 by CH2M Hill. Construction details for temporary monitoring points and monitoring wells are presented in Appendix A.

3.3.2.1 Flow Direction and Gradient

Figure 3.5 shows groundwater elevations for LF-06 in November 1996. Due to perched groundwater levels, data from wells MPA(s), MPB, MPD(s), MPF(s), MPH, and MPJ were not used for contouring. Groundwater flows to the west with a nonuniform gradient ranging from 0.003 foot per foot (ft/ft) to 0.027 ft/ft, and averages 0.0055 ft/ft across the site. The gradient is consistent with values observed in December 1988 and May 1989 (CH2M Hill, 1989), and with values observed in February 1995 and December

TABLE 3.1
SUMMARY OF GROUNDWATER ELEVATION DATA
NOVEMBER 1996
SITE LF-06 RNA TS
COLUMBUS AFB, MISSISSIPPI

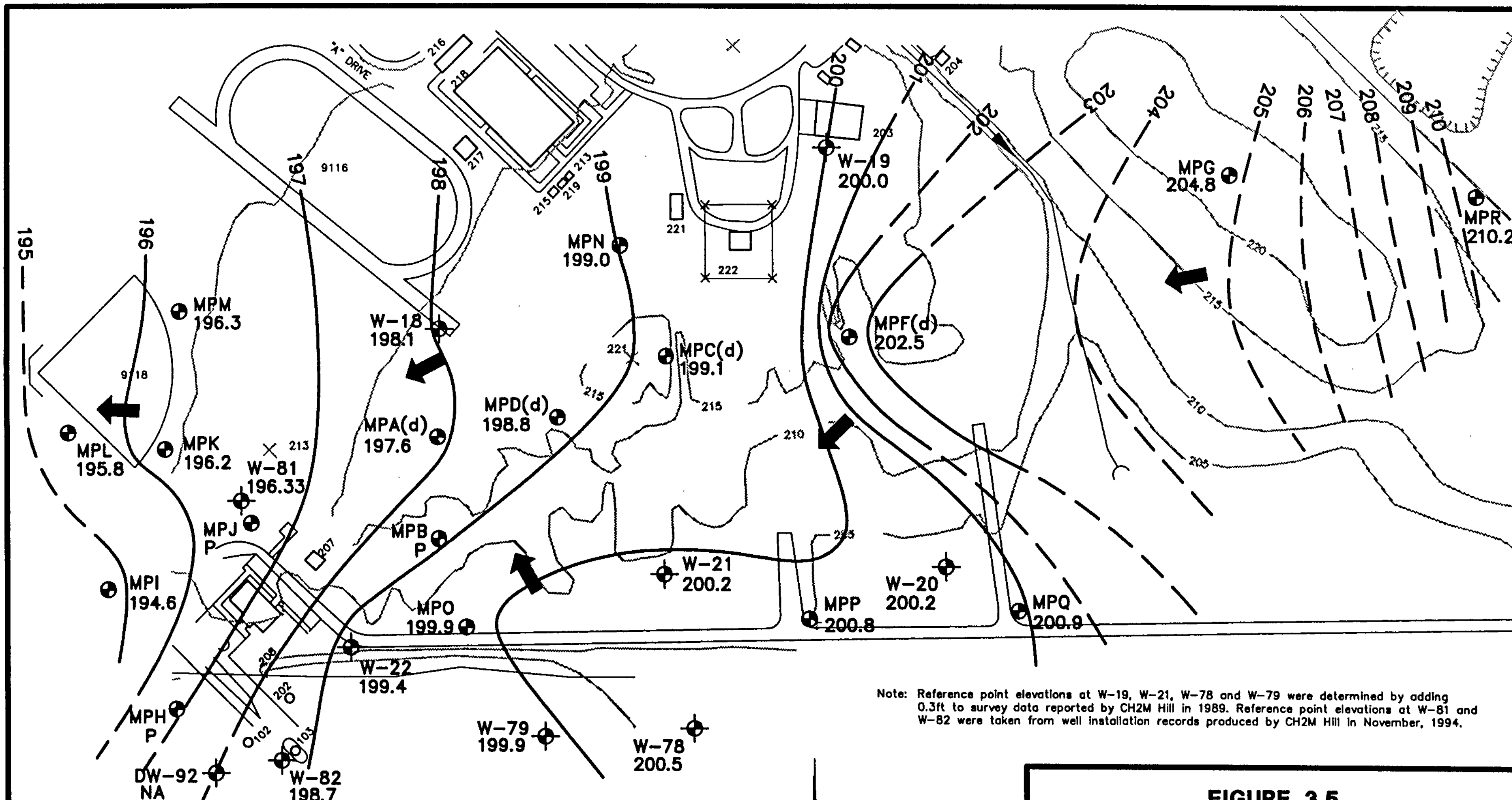
Well Identification	Elevation of Reference Point for Measurements (feet msl)[a/]	Depth to Groundwater (feet)	Groundwater Elevation (feet msl)
W-18	215.6	17.5	198.1
W-19	219.0[b/]	19.0	200.0
W-20	205.6	5.4	200.2
W-21	207.2[b/]	7.0	200.2
W-22	208.7	9.3	199.4
W-78	206.8[b/]	6.3	200.5
W-79	208.0[b/]	8.1	199.9
W-81	212.2[c/]	15.9	196.3
W-82	207.2[c/]	8.5	198.7
MPA (s)	216.7	2.6	214.1*
MPA (d)	217.7	20.1	197.6
MPB	211.9	4.3	207.6*
MPC (s)	218.7	19.8	199.0
MPC (d)	219.9	20.8	199.1
MPD (s)	216.5	15.6	200.9*
MPD (d)	217.6	18.8	198.8
MPF (s)	215.0	1.9	213.1*
MPF (d)	216.0	13.5	202.5
MPG	219.3	14.5	204.8
MPH	208.6	4.1	204.5*
MPI	206.7	12.1	194.6
MPJ	213.4	12.6	200.8*
MPK	209.3	13.2	196.2
MPL	206.6	10.8	195.8
MPM	208.5	12.3	196.3
MPN	219.1	20.1	199.0
MPO	203.6	3.7	199.9
MPP	204.9	4.1	200.8
MPQ	204.3	3.4	200.9
MPR	212.7	2.5	210.2

[a/] Feet msl = feet above mean sea level.

[b/] Reference point elevation determined by adding 0.3 ft to survey data reported by CH2M Hill in 1989.

[c/] Reference point elevation obtained from well installation records produced by CH2M Hill in November 1994.

* Perched groundwater - not used for contouring.



Note: Reference point elevations at W-19, W-21, W-78 and W-79 were determined by adding 0.3ft to survey data reported by CH2M Hill in 1989. Reference point elevations at W-81 and W-82 were taken from well installation records produced by CH2M Hill in November, 1994.

LEGEND

MPK 16.2	MONITORING POINT WITH WATER TABLE ELEVATION (ft msl)
W-78 200.5	MONITORING WELL WITH WATER TABLE ELEVATION (ft msl)
(d)	GROUNDWATER ELEVATION MEASURED IN DEEP MONITORING POINT
P	PERCHED GROUNDWATER
	INFERRED DIRECTION OF GROUNDWATER FLOW
NA	DATA NOT AVAILABLE

0 125 250
FEET

N

FIGURE 3.5

WATER TABLE ELEVATIONS NOVEMBER 1996

Site LF-06 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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1995 (Spencer, 1996a, 1996b). The heads from November 1996 are approximately 1 to 4 feet lower than during the previous sampling events. This variation may be due to seasonal fluctuations in recharge.

One groundwater monitoring point well pair installed for this investigation was used to evaluate vertical hydraulic gradients at LF-06. Because MPA(s), MPD(s), and MPF(s) were not screened below the potentiometric surface, groundwater elevations at these wells represent perched conditions and therefore could not be used to calculate a vertical gradient. Groundwater elevation data collected in November 1996 at monitoring point pair MPC(s)/MPC(d) indicated that a no vertical gradient was not present.

3.3.2.2 Hydraulic Conductivity

In November 1996, Parsons ES conducted falling- and rising-head slug tests at wells W18, W19, W22, W79, W81, and W82. Hydraulic conductivity was calculated using the method of Bower and Rice (1976), as described in Section 2. The average of the falling and rising head test results of these slug tests are summarized in Table 3.2. Hydraulic conductivities ranged from 16 ft/day to 238 ft/day, with an average hydraulic conductivity of 99 ft/day. The slug-test analyses are presented in Appendix A.

TABLE 3.2
1996 SLUG TEST RESULTS
SITE LF-06
RNA TS
COLUMBUS AFB, MISSISSIPPI

WELL	HYDRAULIC CONDUCTIVITY (ft/min)	HYDRAULIC CONDUCTIVITY (ft/day)
W18	0.050	72
W19	0.021	30
W22	0.126	181
W79	0.011	16
W81	0.165	238
W82	0.040	58

3.3.2.3 Effective Porosity

Because of the difficulty involved in accurately determining effective porosity, published literature values for soil types comprising the shallow saturated zone were referenced (Walton, 1988; Domenico and Schwartz, 1990). Estimates of effective porosity for fine to medium sand with gravel range from 0.08 to 0.30. An average effective porosity of 0.25 was assumed for the shallow surficial aquifer at Site LF-06.

3.3.2.4 Advective Groundwater Velocity

The advective velocity of groundwater in the direction parallel to groundwater flow is given by:

$$\bar{v} = \frac{K}{n_e}\frac{dH}{dL}$$

Where: $\bar{v}$ = Average advective groundwater velocity (seepage velocity) [L/T]

K = Hydraulic conductivity [L/T] (99 ft/day)
dH/dL = Gradient [L/L] (0.0055 ft/ft)
n_e = Effective porosity (0.25).

Using this relationship in conjunction with site-specific data, the average advective groundwater velocity across the site in November 1996 was 2.2 ft/day, or approximately 795 feet per year (ft/yr).

3.3.2.5 Preferential Flow Paths

No preferential contaminant migration pathways were identified during the field work phase of this project. Parts of the sanitary sewer system, electrical distribution system, water supply system, and storm drainage system extend onto the site, but are not anticipated to influence migration pathways because of the high hydraulic conductivities associated with native surficial aquifer materials.

3.3.3 Groundwater Use

Groundwater in the shallow aquifer is not used as a local source of potable water within the vicinity of the site. There are five deep on-Base wells that provide potable water to Columbus AFB. The only downgradient well, at Building 363, is located approximately 3,000 feet west of the Site. This well is screened at a depth of 386 to 426 feet bgs within the Tuscaloosa Group of the Eutaw Aquifer. Wells at Buildings 604 and 865 are located 3,000 and 4,500 feet northwest of the Site, respectively. These wells are screened at depths of 396 to 443 feet bgs and 430 to 470 feet bgs within the Tuscaloosa Group of the Eutaw Aquifer, respectively. Columbus AFB plans to connect to the City of Columbus water system in 1997, and subsequently abandon these three wells (Stewart, 1997). Two other wells of unknown depth, at Buildings 1812 and 2052, supply drinking water at their respective locations. These wells are located approximately 11,000 feet to the northwest and 7,000 feet to the north of the site. The four closest private wells, Wells R-55, R-56, R-53, and R-57 are located 3,100 feet to the south, 3,500 feet to the southeast, 3,800 feet to the south, and 4,200 feet to the southeast of the Site, respectively. The closest private well downgradient of the Site, Well R-85, is located 10,000 feet from the site. Private wells R-55 and R-85 are screened in the Eutaw Aquifer. Private wells R-56, R-53, and R-57 are of unknown depth (CH2M Hill, 1989).

3.4 CLIMATE

The climate in northeastern Mississippi is typified by short, cool winters and hot, humid summers. Precipitation averages 56 inches per year, and is evenly distributed throughout the year.

SECTION 4

CONTAMINANT DISTRIBUTION AND EVIDENCE FOR BIODEGRADATION

Soil and groundwater have been contaminated as a result of disposal activities at LF-06. Work during the RI (CH2M Hill, 1989) focused on defining the nature and extent of contamination at the site, and additional monitoring has recently been conducted at the site (Spencer, 1996a). As needed, the data collected during those efforts is used to supplement the data collected during the field phase of this work, presented in the following subsections. In particular, this section focuses on data useful for evaluating and modeling natural attenuation of fuel hydrocarbons and chlorinated solvents dissolved in groundwater.

4.1 CONTAMINANT SOURCES AND SOIL CHEMISTRY

4.1.1 Contaminant Sources

Sources of dissolved groundwater contamination at LF-06 are not clearly defined. It is likely that material disposed in the trenches is the original source of groundwater contamination. However, the exact locations and nature of the releases is not clear from the available data. The low concentrations of dissolved contaminants discussed in Section 4.3 suggest that the presence of a mobile NAPL source is unlikely. In addition, residual NAPL bodies have not been identified or delineated during either previous or current subsurface investigations; therefore, the dissolved contaminant data must be used to infer sources, and as discussed in Section 4.3, these data also suggest that residual sources are relatively small and localized.

A total of 4 soil samples were collected from 3 Geoprobe® boreholes (MPF, MPJ, and MPL) in 1996. These samples were analyzed for fuel hydrocarbons and chlorinated

solvents. The results are summarized in Table 4.1. No contaminants were detected in the samples from MPJ and MPL. Fuel-related compounds were detected in two of the samples, both collected from MPF. In the sample from a depth of 4 to 8 feet bgs, the total BTEX concentration was 373 micrograms per kilogram (μg/kg) [0.373 milligrams per kilogram (mg/kg)], and the total recoverable petroleum hydrocarbons (TRPH) concentration was 760 mg/kg. The high proportion of TRPH relative to BTEX suggests that the residual soil contamination in this area consists partially of weathered motor fuel or jet fuel, if not motor oil or waste oil. These detections also suggests that a source of groundwater contamination is present in the vicinity of MPF, possibly related to the apparent burial trench just east of MPF (Figure 2.1). The sample from a depth of 8 to 10 feet bgs in MPF contained toluene at a concentration of 1.4 μg/kg.

Chlorinated compounds also were detected in both samples from MPF. In the shallow sample, chlorobenzene (CB) was detected at a concentration of 4,900 μg/kg, while 1,2-dichlorobenzene (1,2-DCB) and 1,3-DCB were detected at concentrations of 7.7 μg/kg and 12 μg/kg, respectively, In the deeper sample, CB was detected at a concentration of 2J μg/kg. Also, vinyl chloride (VC) and dichloromethane were detected at low concentrations (less than 2 μg/kg) in the shallow sample, but the presence of these compounds could not be confirmed by the laboratory's mass spectrometer.

4.1.2 Total Organic Carbon in Soil

Total organic carbon (TOC) concentrations are used to estimate the amount of organic matter sorbed to soil particles or trapped in the interstitial passages of a soil matrix. The TOC concentration in the saturated zone is an important parameter used to estimate the amount of contaminant that could potentially be sorbed to the aquifer matrix. Sorption results in retardation of the contaminant plume relative to the average advective groundwater velocity. In addition, TOC can be used as a gross indicator of organic compounds that are available as a source of carbon and electron donors (or substrate) for a microbial population.

TABLE 4.1
SOIL ANALYTICAL DATA
SITE LF-06 RNA TS
COLUMBUS AFB, MISSISSIPPI

Sample ID	Date Sampled	Depth (feet bgs[a/])	Benzene (µg/kg[b/])	Toluene (µg/kg)	Ethylbenzene (µg/kg)	Total Xylenes (µg/kg)	Total BTEX (µg/kg)	1,3,5-TMB (µg/kg)	1,2,4-TMB (µg/kg)	1,2,3-TMB (µg/kg)	1,2,3,4-TEMB (µg/kg)	TRPH (mg/kg[c/])	CB (µg/kg)	1,2-DCB (µg/kg)	1,3-DCB (µg/kg)
MPF	11/15/96	4-8	69	10	84	210	373	89	240	110	190	760	4,900	7.7	12
MPF[d/]	11/15/96	8-10	ND[e/]	1.4	ND	ND	1.4	ND	ND	ND	ND	ND	2J[f/]	ND	ND
MPJ	11/8/96	18	NA[g/]	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND
MPL	11/9/96	14-18	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

[a/] bgs = below ground surface.
[b/] µg/kg = micrograms per kilogram.
[c/] mg/kg = milligrams per kilogram.
[d/] Also detected in this sample were VC and dichloromethane; however, the presence of these compounds could not be confirmed by mass spectrometer.
[e/] ND = Analyte not detected.
[f/] J = Estimated value.
[g/] NA = Not analyzed.
Note: BTEX = benzene, toluene, ethylbenzene, and xlyenes; TMB = trimethylbenzene; TEMB = tetramehtylbenzene; CB = chlorobenzene; and DCB = dichlorobenzene.

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Soil TOC concentrations were measured in 2 samples from 2 Geoprobe® locations in 1996. These samples were collected from a depth of 18 feet in the borehole for MPJ and from a depth of 14 to 18 feet in the borehole for MPL. Both samples were collected from below the water table or in the capillary fringe. In both samples, soil TOC concentrations were reported to be less than 0.06 percent.

Despite the fact that reported soil TOC concentrations are below 0.06 percent, sorption may play an important role in dissolved contaminant attenuation. For BTEX compounds and most of the chlorinated solvents detected at LF-06 (the notable exception being VC), retardation of contaminant migration is significant when TOC concentrations are on the order of 0.01 percent. The method detection limit was used as an approximation of TOC levels in site soils for modeling purposes. Even though it is unclear whether soil TOC levels are significantly less than 0.06 percent, it is expected that some sorption, and therefore some contaminant retardation with respect to groundwater velocity, is occurring.

4.2 OVERVIEW OF HYDROCARBON BIODEGRADATION

Mechanisms for natural attenuation of chlorinated solvents and BTEX include biodegradation, dispersion, dilution from recharge, sorption, and volatilization. Of these processes, biodegradation is the only mechanism working to transform contaminants into ultimately innocuous byproducts. Intrinsic bioremediation occurs when indigenous microorganisms work to bring about a reduction in the total mass of contamination in the subsurface without the addition of nutrients. In order to provide a foundation for interpreting site data, the following subsections review the major bioremediation processes that act upon chlorinated solvents and BTEX.

BTEX compounds and several chlorinated solvents are present in groundwater at LF-06. As a result, the following sections discuss the biodegradation of both BTEX and chlorinated solvents. Because the terminology describing biodegradation of both types of compounds is similar, a generalized review of the processes is presented first.

4.2.1 Review of Biodegradation Processes

Microorganisms obtain energy for cell production and maintenance by facilitating thermodynamically advantageous redox reactions involving the transfer of electrons from electron donors to available electron acceptors. This results in the oxidation of the electron donor and the reduction of the electron acceptor. Electron donors may be natural organic carbon, fuel hydrocarbon compounds, and less-chlorinated solvents [e.g., VC, dichloroethene (DCE), dichloroethane (DCA), or chlorinated benzenes ranging from CB to tetrachlorobenzene]. Fuel hydrocarbons or solvents are completely degraded or detoxified if they are utilized as the primary electron donor (i.e., as a primary substrate or carbon source) for microbial metabolism (Bouwer, 1992). Electron acceptors are elements or compounds that occur in relatively oxidized states, and include oxygen, nitrate, ferric iron, sulfate, manganese, carbon dioxide, and highly chlorinated solvents [e.g., tetrachloroethene (PCE), trichloroethene (TCE), tetrachloroethane (PCA), trichloroethane (TCA), and polychlorinated benzenes].

The driving force of biodegradation is electron transfer, which is quantified by the Gibbs free energy of the reaction ($\Delta G°_r$) (Stumm and Morgan, 1981; Bouwer, 1994; Godsey, 1994). The value of $\Delta G°_r$ represents the quantity of free energy consumed ($\Delta G°_r > 0$) or yielded ($\Delta G°_r < 0$) to the system during the reaction. Although thermodynamically favorable, most of the reactions involved in biodegradation of fuel hydrocarbons or chlorinated hydrocarbons cannot proceed abiotically because of the lack of activation energy. Microorganisms are capable of providing the necessary activation energy; however, they will facilitate only those redox reactions that have a net yield of energy (i.e. $\Delta G°_r < 0$). Most reactions involving biodegradation of contaminants do yield energy to the microbes; however, in many cases specific geochemical conditions are necessary for this reaction to be favorable and to allow the appropriate microbial population to develop and grow.

Microorganisms preferentially utilize electron acceptors while metabolizing hydrocarbons (Bouwer, 1992). DO is utilized first as the prime electron acceptor. It is under these conditions (i.e., aerobic conditions) that fuel hydrocarbons and the less chlorinated solvents are most commonly used as electron donors. After the DO is consumed, anaerobic microorganisms use native electron acceptors in the following order of preference: nitrate, manganese, ferric iron hydroxide, sulfate, and finally carbon dioxide. Under anaerobic conditions, BTEX compounds and other fuel hydrocarbons are still used as electron donors. Chlorinated solvents that are amenable to reductive dehalogenation are generally used as electron acceptors when aquifer conditions are such that sulfate or carbon dioxide is the preferred electron acceptor.

In addition to being controlled by the energy yield of the reaction, the expected sequence of redox processes is also a function of the oxidizing potential of the groundwater. This potential is a measure of the relative tendency of a solution or chemical reaction to accept or transfer electrons. As each subsequent electron acceptor is utilized, the groundwater becomes more reducing, and the redox potential of the water decreases. The main force driving this change in redox potential is microbially mediated redox reactions. Redox potential can be used as an indicator of which redox reactions may be operating at a site. Environmental conditions and microbial competition ultimately determine which processes will dominate.

Depending on the types and concentrations of electron acceptors present (e.g., nitrate, sulfate, carbon dioxide), pH conditions, and redox potential, anaerobic biodegradation can occur by denitrification, manganese reduction, ferric iron reduction, sulfate reduction, or methanogenesis. Other, less common anaerobic degradation mechanisms such as manganese or nitrate reduction may dominate if the physical and chemical conditions in the subsurface favor use of these electron acceptors. Vroblesky and Chapelle (1994) show that the dominant terminal electron accepting process can vary both temporally and spatially in an aquifer with fuel hydrocarbon contamination.

4.2.2 Biodegradation of BTEX

Numerous laboratory and field studies have shown that hydrocarbon-degrading bacteria can participate in the degradation of many of the chemical components of fuel hydrocarbons, including the BTEX compounds (e.g., Jamison *et al.*, 1975; Atlas, 1981, 1984, 1988; Gibson and Subramanian, 1984; Reinhard *et al.*, 1984; Young, 1984; Bartha, 1986; Wilson *et al.*, 1986, 1987, and 1990; Barker *et al.*, 1987; Baedecker *et al.*, 1988; Lee, 1988; Chiang *et al.*, 1989; Grbic-Galic, 1989 and 1990; Cozzarelli *et al.*, 1990; Leahy and Colewell, 1990; Altenschmidt and Fuchs, 1991; Alvarez and Vogel, 1991; Baedecker and Cozzarelli, 1991; Ball *et al.*, 1991; Bauman, 1991; Borden, 1991; Brown *et al.*, 1991; Edwards *et al.*, 1991 and 1992; Evans *et al.*, 1991a and 1991b; Haag *et al.*, 1991; Hutchins and Wilson, 1991; Hutchins *et al.*, 1991a and 1991b; Beller *et al.*, 1992; Bouwer, 1992; Edwards and Grbic-Galic, 1992; Thierrin *et al.*, 1992; Malone *et al.*, 1993; Davis *et al.*, 1994). Fuel hydrocarbons biodegrade naturally when an indigenous population of hydrocarbon-degrading microorganisms is present in the aquifer and sufficient concentrations of electron acceptors and nutrients are available to these organisms.

During biodegradation of fuel hydrocarbons, the fuel compounds are used as electron donors. They are the primary substrate ("food") for the microbes, while the electron acceptors provide the oxidant used to reduce (metabolize) the substrate and produce energy. In most subsurface environments, both aerobic and anaerobic degradation of fuel hydrocarbons can occur, often simultaneously in different parts of the plume. The nearly ubiquitous nature of these processes is well documented (e.g., Rice *et al.*, 1995; Wiedemeier *et al.*, 1995; Kuehne and Busheck, 1996; and Mace *et al.*, 1997). Aerobic destruction of BTEX compounds dissolved in groundwater results in the consumption (reduction) of DO and the formation of carbon dioxide. Anaerobic destruction of the BTEX compounds is associated with the accumulation of fatty acids, production of methane, solubilization of iron, and reduction of nitrate and sulfate (Cozzarelli *et al.*, 1990; Wilson *et al.*, 1990).

4.2.3 Biodegradation of Chlorinated Solvents

Chlorinated solvents can be transformed, directly or indirectly, by biological processes (e.g., Bouwer *et al.*, 1981; Miller and Guengerich, 1982; Reineke and Knackmuss, 1984; Wilson and Wilson, 1985; de Bont *et al.*, 1986; Nelson *et al.*, 1986; Spain and Nishino, 1987; Bouwer and Wright, 1988; Little *et al.*, 1988; Mayer *et al.*, 1988; Arciero *et al.*, 1989; Cline and Delfino, 1989; Freedman and Gossett, 1989; Folsom *et al.*, 1990; Harker and Kim, 1990; Alvarez-Cohen and McCarty, 1991a, 1991b; DeStefano *et al.*, 1991; Henry, 1991; Sander *et al.*, 1991; McCarty *et al.*, 1992; Hartmans and de Bont, 1992; Chapelle, 1993; McCarty and Semprini, 1994; Vogel, 1994; Suflita and Townsend, 1995; Bradley and Chapelle, 1996; Klier *et al.*, 1996; Spain, 1996). Biodegradation of chlorinated solvents, also termed chlorinated aliphatic hydrocarbons (CAHs) and chlorinated benzenes results from the same general processes that bring about biodegradation of fuel hydrocarbons. However, a more complex series of processes often is involved, and CAHs and chlorinated benzenes may act as either substrates (electron donors) or electron acceptors depending upon what geochemical conditions prevail.

Whereas BTEX are biodegraded in essentially one step by acting as an electron donor/carbon source, CAHs and chlorinated benzenes may undergo several types of biodegradation involving several steps. Chlorinated solvents may undergo biodegradation through three different pathways: use as an electron acceptor, use as an electron donor, or cometabolism, which is degradation resulting from exposure to a catalytic enzyme fortuitously produced during an unrelated process. At a given site, one or all of these processes may be operating, although at many sites the use of CAHs as electron acceptors appears to be the most likely.

In a pristine aquifer, native organic carbon is utilized as an electron donor and DO is utilized first as the prime electron acceptor. Where anthropogenic carbon (e.g., fuel hydrocarbons, less-chlorinated CAHs, or chlorinated benzenes with four or fewer chlorines) is present, it also may be utilized as an electron donor. Most chlorinated

solvents that can act as electron donors have thus far only been demonstrated to do so under aerobic conditions, with the notable exception of VC (Bradley and Chapelle, 1996). After the DO is consumed, anaerobic microorganisms typically use native electron acceptors (as available) in the following order of preference: nitrate, ferric iron oxyhydroxide, sulfate, and finally carbon dioxide. Evaluation of the distribution of these electron acceptors can provide evidence of where and how biodegradation of chlorinated solvents is occurring. In addition, because solvents may be used as electron acceptors or electron donors (in competition with other acceptors or donors), isopleth maps showing the distribution of these compounds also will provide evidence of the types of biodegradation processes acting at a site. A more complete description of the main types of biodegradation reactions affecting chlorinated solvents dissolved in groundwater is presented in the following subsections.

4.2.3.1 Electron Acceptor Reactions (Reductive Dehalogenation)

Under anaerobic conditions, biodegradation of chlorinated solvents usually proceeds through a process called reductive dehalogenation. During this process, the halogenated hydrocarbon is used as an electron acceptor, not as a source of carbon, and a halogen atom is removed and replaced with a hydrogen atom. As an example, Figure 4.1 illustrates the transformation of chlorinated ethenes via reductive dehalogenation. In general, reductive dehalogenation of chlorinated ethenes occurs by sequential dehalogenation from PCE to TCE to DCE to VC to ethene. An analogous pattern for chlorinated ethanes might be PCA to TCA to DCA to CA, and for chlorinated benzenes the pattern might be tetrachlorobenzene (TeCB) to trichlorobenzene (TCB) to DCB to CB. Depending upon environmental conditions, these sequences may be interrupted, with other processes (e.g.,

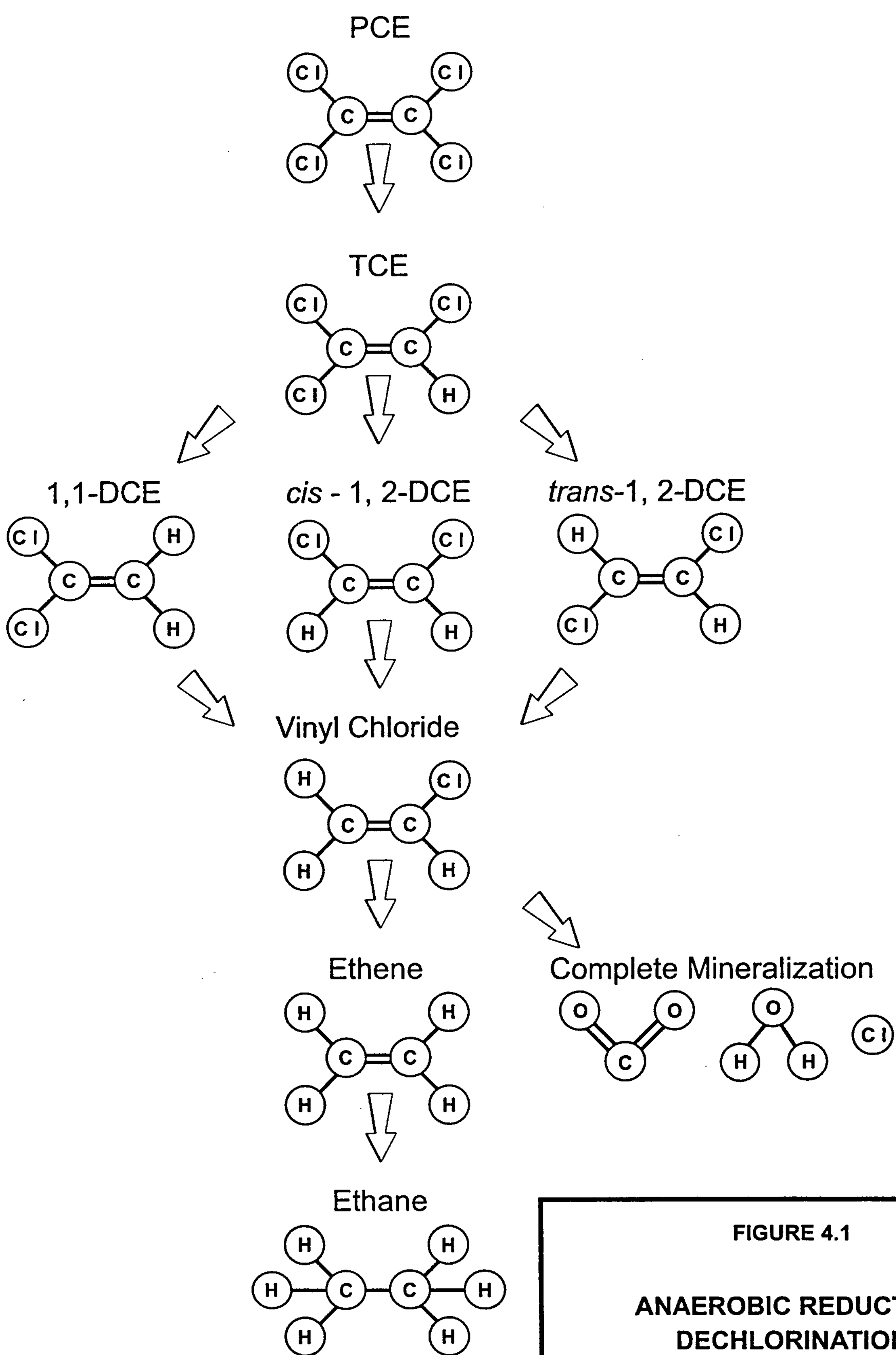

FIGURE 4.1

ANAEROBIC REDUCTIVE DECHLORINATION

LF-06 RNA TS
Columbus AFB, Mississippi

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Denver, Colorado

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aerobic or abiotic degradation) then acting upon the products. Reductive dehalogenation of chlorinated solvent compounds is associated with the accumulation of daughter products and an increase in chloride.

Reductive dehalogenation affects chlorinated compounds differently. Of the ethenes, PCE is the most susceptible to reductive dehalogenation because it is the most oxidized. Conversely, VC is the least susceptible to reductive dehalogenation because it is the least oxidized of these compounds. Likewise, hexachlorobenzene is more susceptible to reductive dehalogenation than less-chlorinated benzenes. In general, the rate of reductive dehalogenation of chlorinated solvents has been observed to decrease as the degree of chlorination decreases (Vogel and McCarty, 1985; Bouwer, 1994). Murray and Richardson (1993) have postulated that this rate decrease may explain the accumulation of VC in PCE and TCE plumes that are undergoing reductive dehalogenation.

In addition to being affected by the degree of chlorination of the compound, reductive dehalogenation also can be controlled by the redox conditions of the site groundwater system. In general, reductive dehalogenation has been demonstrated under anaerobic nitrate- and sulfate-reducing conditions, but the most rapid biodegradation rates, affecting the widest range of compounds, occur under methanogenic conditions (Bouwer, 1994). Dehalogenation of PCE and TCE to DCE can proceed under mildly reducing conditions such as nitrate reduction or iron (III) reduction (Vogel *et al.*, 1987), while the transformation of DCE to VC, or the transformation from VC to ethene requires more strongly reducing conditions (Freedman and Gossett, 1989; DeStefano *et al.*, 1991; De Bruin *et al.*, 1992).

Reductive dehalogenation of some compounds also has been shown to preferentially produce specific daughter compounds. For example, during reductive dehalogenation of TCE or PCE, all three isomers of DCE can theoretically be produced; however, Bouwer (1994) reports that under the influence of biodegradation, *cis*-1,2-DCE is a more common

intermediate than *trans*-1,2-DCE, and that 1,1-DCE is the least prevalent intermediate of the three DCE isomers.

When chlorinated compounds are used as electron acceptors, there must be an appropriate source of carbon for microbial growth in order for reductive dehalogenation to occur (Bouwer, 1994). Potential carbon sources/electron donors can include low-molecular-weight compounds (e.g., lactate, acetate, methanol, or glucose) present in natural organic matter, fuel hydrocarbons, or less-chlorinated solvents (as discussed below).

4.2.3.2 Electron Donor Reactions

Under aerobic conditions some chlorinated solvents can be utilized as the primary substrate (i.e., electron donor) in biologically mediated redox reactions (McCarty and Semprini, 1994). In this type of reaction, the facilitating microorganism obtains energy and organic carbon from the degraded compound. In contrast to reactions in which the chlorinated compound is used as an electron acceptor, only the least oxidized chlorinated solvents (e.g., VC, DCE, or chlorobenzene) may be utilized as electron donors in biologically mediated redox reactions. Also, chlorinated benzenes with up to four chlorines (i.e., CB, DCB isomers, TCB isomers, and TeCB isomers) have been shown to act as electron donors under aerobic conditions.

For example, while Murray and Richardson (1993) write that microorganisms are generally believed to be incapable of growth using TCE and PCE, other less chlorinated CAHs have been shown to be used as substrates. Davis and Carpenter (1990) describe the aerobic oxidation of VC in groundwater. McCarty and Semprini (1994) describe investigations in which VC and 1,2-DCA were shown to serve as primary substrates. These authors also document that dichloromethane has the potential to function as a primary substrate under either aerobic or anaerobic environments. Klier *et al.* (1996) describe aerobic mineralization of all three isomers of DCE. In addition, Bradley and

Chapelle (1996) show evidence of oxidation of VC under iron-reducing conditions so long as there is sufficient bioavailable iron (III). Aerobic metabolism of VC may be characterized by a loss of VC mass, a decreasing molar ratio of VC to other CAH compounds, and rarely, the presence of chloromethane.

CB and polychlorinated benzenes (up to and including TeCB) have been shown to be biodegradable under aerobic conditions. Several studies have shown that bacteria are able to utilize CB (Reineke and Knackmuss, 1984), 1,4-DCB (Reineke and Knackmuss, 1984; Schraa *et al.*, 1986; Spain and Nishino, 1987), 1,3-DCB (de Bont *et al.*, 1986), 1,2-DCB (Haigler *et al.*, 1988), 1,2,4-TCB (van der Meer *et al.*, 1987; Sander *et al.*, 1991), and 1,2,4,5-TeCB (Sander *et al.*, 1991) as primary growth substrates in aerobic systems. Nishino *et al.* (1994) note that aerobic bacteria able to grow on chlorobenzene have been detected at a variety of chlorobenzene-contaminated sites, but not at uncontaminated sites. Spain (1996) notes that this provides strong evidence that the bacteria are selected for their ability to derive carbon and energy from chlorobenzene degradation *in situ*. The pathways for all of these reactions are similar, and are also similar to that of benzene (Chapelle, 1993; Spain, 1996). The only significant difference between aerobic oxidation of chlorobenzenes and benzene is the required elimination of chlorine. Anaerobic oxidation of chlorobenzenes has not been conclusively documented, although little work has been done on the subject (Spain, 1997).

4.2.3.3 Cometabolism

When a chlorinated solvent is biodegraded through cometabolism, it serves as neither an electron acceptor nor a primary substrate in a biologically mediated redox reaction. Instead, the degradation of the compound is catalyzed by an enzyme or cofactor that is fortuitously produced by organisms for other purposes. The organism receives no known benefit from the degradation of the solvent; rather the cometabolic degradation of the solvent may in fact be harmful to the microorganism responsible for the production of the enzyme or cofactor (McCarty and Semprini, 1994).

Cometabolism is best documented for chlorinated ethenes in aerobic environments, although it potentially could occur with other chlorinated solvents or under anaerobic conditions. Aerobic degradation pathways for chlorinated ethenes are illustrated in Figure 4.2. It has been reported that under aerobic conditions chlorinated ethenes, with the exception of PCE, are susceptible to cometabolic degradation (Murray and Richardson, 1993; Vogel, 1994; McCarty and Semprini, 1994). Vogel (1994) further elaborates that the cometabolism rate increases as the degree of dehalogenation decreases.

In the cometabolic process, TCE is indirectly transformed by bacteria as they use BTEX or another substrate to meet their energy requirements. Therefore, TCE does not enhance the degradation of BTEX or other carbon sources, nor will its cometabolism interfere with the use of electron acceptors involved in the oxidation of those carbon sources. Given this relationship, it would follow that depletion of suitable substrates (BTEX or other organic carbon sources) likely limits cometabolism of CAHs.

4.2.3.4 Behavior of Chlorinated Solvent Plumes

Chlorinated solvent plumes can exhibit three types of behavior depending on the amount of solvent, the amount of organic (native and/or anthropogenic) carbon in the aquifer, the distribution and concentration of natural electron acceptors, and the types of electron acceptors being utilized. Individual plumes may exhibit all three types of behavior in different portions of the plume. The different types of plume behavior are summarized below.

4.2.3.4.1 Type 1 Behavior

Type 1 behavior occurs where the primary substrate is anthropogenic carbon (e.g., BTEX or landfill leachate), and this anthropogenic carbon drives reductive dechlorination. When evaluating natural attenuation of a plume exhibiting type 1 behavior the following questions must be answered:

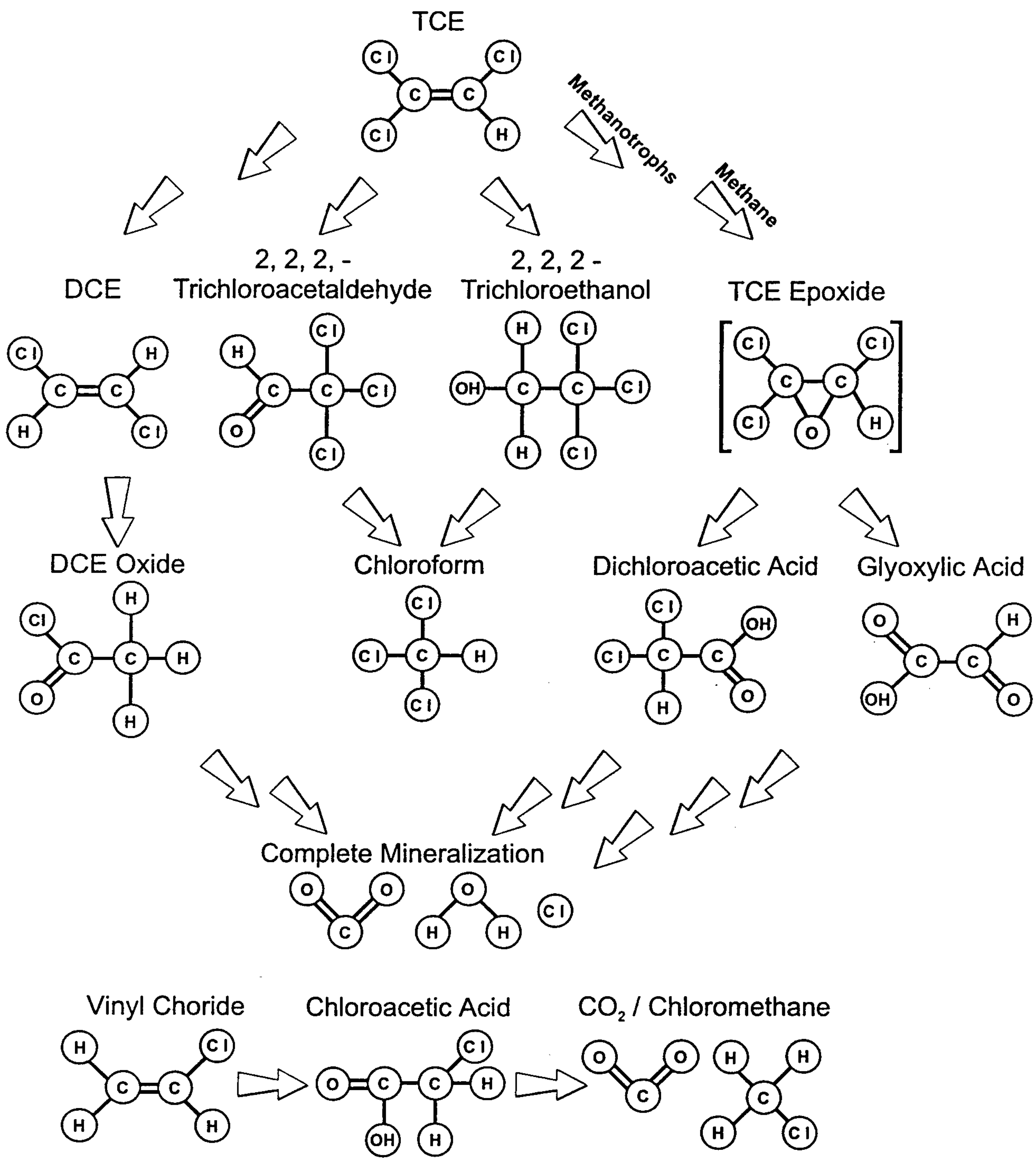

FIGURE 4.2

AEROBIC DECHLORINATION

LF-06 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

1) Is the electron donor supply adequate to allow microbial reduction of the chlorinated organic compounds? In other words, will the microorganisms "strangle" before they "starve" [i.e., will they run out of chlorinated aliphatic hydrocarbons (electron acceptors) before they run out of primary substrate (anthropogenic carbon)]?

2) What is the role of competing electron acceptors (e.g., DO, nitrate, iron (III) and sulfate)?

3) Are VC and other less-chlorinated solvents being oxidized, or are they being reduced?

Type 1 behavior results in the rapid and extensive degradation of the highly chlorinated solvents such as PCE, TCE, or polychlorinated benzenes.

4.2.3.4.2 Type 2 Behavior

Type 2 behavior dominates in areas that are characterized by relatively high concentrations of biologically available native organic carbon. This natural carbon source drives reductive dehalogenation (i.e., the primary substrate for microorganism growth is native organic carbon). When evaluating natural attenuation of a Type 2 chlorinated solvent plume, the same questions as those posed in the description of Type 1 behavior must be answered. Type 2 behavior generally results in slower biodegradation of the highly chlorinated solvents than Type 1 behavior, but under the right conditions (e.g., areas with high natural organic carbon contents), this type of behavior also can result in rapid degradation of these compounds.

4.2.3.4.3 Type 3 Behavior

Type 3 behavior dominates in areas that are characterized by low concentrations of native and/or anthropogenic carbon, and concentrations of DO that are greater than 1.0 mg/L. Under these aerobic conditions reductive dehalogenation will not occur. Thus there

is little or no removal of PCE and TCE. Biodegradation may proceed via the much slower process of cometabolism, but will be limited by the low concentrations of native or anthropogenic carbon. The most significant natural attenuation mechanisms for CAHs will be advection, dispersion, and sorption. However, VC can be rapidly oxidized under these conditions, DCE may be oxidized, CBs may be oxidized, and cometabolism also may occur.

4.2.3.4.4 Mixed Behavior

As mentioned above, a single chlorinated solvent plume can exhibit all three types of behavior in different portions of the plume. This can be beneficial for natural biodegradation of chlorinated solvent plumes. For example, Wiedemeier *et al.* (1996a) describe a CAH plume at Plattsburgh AFB, New York that exhibits Type 1 behavior in the source area and Type 3 behavior downgradient from the source. The best scenario involves a plume in which PCE, TCE, and DCE are reductively dehalogenated (Type 1 or Type 2 behavior), then VC is oxidized (Type 3 behavior), either aerobically or via iron reduction. VC is oxidized to carbon dioxide in this type of plume and does not accumulate. The following sequence of reactions occurs in a plume that exhibits this type of mixed behavior:

$$\text{PCE} \rightarrow \text{TCE} \rightarrow \text{DCE} \rightarrow \text{VC} \rightarrow \text{Carbon Dioxide}$$

In general, the TCE, DCE, and VC may attenuate at approximately the same rate, and thus these reactions may be confused with simple dilution. Note that no ethene is produced during this reaction. VC is removed from the system much faster under these conditions than it is under VC-reducing conditions.

A less desirable scenario, but one in which all contaminants may be entirely biodegraded, involves a plume in which all CAHs are reductively dehalogenated via Type 1 or Type 2 behavior. VC is reduced to ethene, which may be further reduced to ethane or methane. The following sequence of reactions occur in this type of plume:

PCE → TCE → DCE → VC → Ethene or Ethane

This sequence has been investigated by Freedman and Gossett (1989). In this type of plume, VC degrades more slowly than TCE, and thus tends to accumulate.

4.2.4 Abiotic Degradation of Chlorinated Solvents

Chlorinated solvents dissolved in groundwater may also be degraded by abiotic mechanisms, although the reactions may not be complete and often result in the formation of a toxic intermediate. The most common abiotic reactions affecting chlorinated solvents are hydrolysis and dehydrohalogenation. Hydrolysis is a substitution reaction in which a halogen substituent is replaced with a hydroxyl (OH^-) group from a water molecule. Dehydrohalogenation is an elimination reaction in which a halogen is removed from a carbon atom, followed by removal of a hydrogen atom from an adjacent carbon atom, with a double bond between the carbon atoms being produced. Other possible reactions include oxidation and reduction, although Butler and Barker (1996) note that no abiotic oxidation reactions involving common halogenated solvents have been reported in the literature. They also note that reduction reactions are most commonly microbially mediated.

Hydrolysis of chlorinated methanes and ethanes has been well-demonstrated in the literature (e.g., Vogel *et al.*, 1987; Jeffers *et al.*, 1989; Vogel, 1994; Butler and Barker, 1996). The likelihood that a solvent will hydrolyze is partly dependent upon the number of halogen substituents, typically with fewer halogens resulting in more rapid hydrolysis. Dehydrohalogenation, on the other hand, is more likely to take place as the number of halogen substituents increases. One common solvent for which abiotic degradation reactions have been well-documented is 1,1,1-TCA. 1,1,1-TCA may be transformed through a series of abiotic processes (including hydrolysis) to acetic acid. Vogel and McCarty (1987) demonstrated that 1,1,1-TCA can also dehydrohalogenate to 1,1-DCE, and Jeffers *et al.* (1989) demonstrated that 1,1,2-TCA also reacts in the same manner to form 1,1-DCE. Also, once TCA is reductively dehalogenated to chloroethane (CA), it can

then hydrolyze to ethanol (Vogel and McCarty, 1987) or dehydrohalogenate to VC (Jeffers *et al.*, 1989).

Butler and Barker (1996) note that attributing changes in the presence, absence, or concentration of halogenated solvents to abiotic processes is usually difficult, particularly on the field scale. Solvents may undergo both biotic and abiotic degradation, and discerning the effects of each mechanism (on the field scale), if possible, would be very difficult. Also, as Butler and Barker (1996) note, the breakdown products of some reactions such as hydrolysis (e.g., acids and alcohols) may be more easily degraded (biotically or abiotically); these products also require additional analyses that may not be feasible for a field investigation. This makes collection of field evidence to demonstrate hydrolysis very difficult to collect and interpret, and Butler and Barker (1996) note that such evidence has not been successfully collected and presented. Evidence of dehydrohalogenation is also difficult to collect, although the presence of 1,1-DCE in conjunction with 1,1,1-TCA can provide a tentative indication that the process is ongoing, and strong evidence where it is known that no DCE has been released.

4.3 DISTRIBUTION OF HYDROCARBONS AND DAUGHTER PRODUCTS

The first step for evaluating the occurrence and methods of biodegradation of chlorinated hydrocarbons and fuel hydrocarbons is to look at the distribution of target compounds and the products of biodegradation of those compounds. At many sites such as LF-06, dissolved groundwater contamination consists of a mixture of compounds, some of which may be electron donors, some of which may be electron acceptors, and some of which may be either donors or acceptors. It is therefore important to evaluate the distribution of all relevant compounds and the spatial relationships between those plumes.

For example, it is useful to determine if a source of dissolved electron donors (e.g., BTEX) coincides with a plume of dissolved contaminants that are most likely to be used as electron acceptors. The donors are needed to fuel biodegradation reactions that will either use some contaminants as electron acceptors or that will produce geochemical conditions

that make the use of contaminants as electron acceptors more favorable. Also, because reductive dehalogenation is the most common biodegradation reaction involving chlorinated hydrocarbons, it is useful to look for the presence of compounds that are most likely the product of biodegradation reactions, such as *cis*-1,2-DCE or VC. These compounds are rarely released to groundwater, but are products of reductive dehalogenation. In addition, if *cis*-1,2-DCE is clearly the most common isomer of DCE, then the occurrence of reductive dehalogenation can be inferred.

The following sections present contaminant and daughter product distributions at LF-06, providing the initial evidence that dissolved fuels and chlorinated solvents are biodegrading. This evidence alone is not conclusive, but when combined with geochemical evidence presented in later sections, it is a significant indicator of biodegradation.

4.3.1 Fuel Hydrocarbons

Fuel hydrocarbons detected in groundwater at LF-06 include all of the BTEX compounds, as well as trimethylbenzene (TMB) isomers, 1,2,3,4-tetramethylbenzene (TEMB), and total volatile hydrocarbons (TVH) as gasoline. Results for fuel hydrocarbon analyses performed on samples collected in November 1996 are presented in Table 4.2, and the distribution of total BTEX is shown on Figure 4.3. Where detected, total BTEX concentrations ranged from 0.4 to 48 micrograms per liter (μg/L). Detected benzene concentrations ranged from 0.4 to 12 μg/L, with concentrations exceeding the USEPA maximum contaminant level (MCL) of 5 μg/L at only one location. At that location, MPF(s), the benzene concentration was 12 μg/L. At MPF(s), the monitoring point is screened in a perched zone above the water table. None of the detected toluene, ethylbenzene, or xylenes concentrations exceeded MCLs.

TMB isomers were detected in 6 wells/points, with concentrations ranging from 0.5 μg/L to 10 μg/L. Except at MPB (in a perched zone), samples containing TMB

TABLE 4.2
GROUNDWATER QUALITY DATA SUMMARY
FOR BTEX, TMBs, AND TVH
SITE LF-06 RNA TS
COLUMBUS AFB, MISSISSIPPI

Sample ID	Date Sampled	Benzene (µg/L[a])	Toluene (µg/L)	Ethyl-Benzene (µg/L)	Total Xylenes (µg/L)	Total BTEX (µg/L)	1,3,5-TMB (µg/L)	1,2,4-TMB (µg/L)	1,2,3-TMB (µg/L)	1,2,3,4-TEMB (µg/L)	TVH-Gasoline (mg/L[b])
W18	11/15/96	1.3	ND[c]	ND	ND	1.3	ND	ND	ND	ND	ND
W19	11/17/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
W20	11/14/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
W21	11/14/96	3.6	ND	ND	ND	3.6	ND	ND	ND	0.5	ND
W22	11/13/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
W1[d]	11/13/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
W78	11/14/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
W2[e]	11/14/96	NA[f]	NA	NA	NA	NA	NA	NA	NA	NA	ND
W79	11/15/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
W81	11/13/96	0.9	ND	ND	ND	0.9	ND	ND	ND	1.3	ND
W82	11/15/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MPA(s)	11/17/96	ND	ND	ND	ND	ND	ND	ND	ND	4.2	ND
MPA(d)	11/17/96	3.0	ND	ND	ND	3	ND	ND	ND	0.9	ND
MPB	11/18/96	ND	ND	ND	ND	ND	ND	0.9	ND	0.6	ND
MPC(s)	11/17/96	1.8	ND	ND	ND	1.8	ND	ND	ND	ND	ND
MPC(d)	11/17/96	1.8	ND	ND	ND	1.8	ND	ND	ND	ND	ND
MPD(d)	11/17/96	2.2	ND	ND	ND	2.2	ND	0.5	ND	1.7	ND
MPF(s)	11/18/96	12	ND	22	14	48	3.4	9.9	5.1	5.7	0.6
MPV[g]	11/18/96	12	ND	21	14	47	3.5	10	4.9	5.0	0.6
MPF(d)	11/17/96	2.1	3.2	0.5	1.3	7.1	ND	ND	ND	ND	ND
MPG	11/18/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MPH	11/15/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MPI	11/15/96	0.7	ND	ND	ND	0.7	ND	ND	ND	ND	ND
MPJ	11/17/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MPK	11/15/96	0.4	ND	ND	ND	0.4	ND	ND	ND	ND	ND
MPL	11/15/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
W3[h]	11/18/96	15	1.2	2.7	3.5	22.4	ND	0.4	8.4	27	0.3
MPM	11/13/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MPN	11/17/96	1.6	ND	ND	ND	1.6	ND	ND	ND	ND	ND
MPO	11/14/96	2.0	ND	ND	0.6	2.6	ND	0.6	ND	ND	ND
MPP	11/14/96	3.4	ND	ND	ND	3.4	ND	ND	ND	ND	ND
MPQ	11/14/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MPR	11/17/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

[a] µg/L = micrograms per liter.
[b] mg/L = milligrams per liter.
[c] ND = Analyte not detected.
[d] W1 is a duplicate sample of W22.
[e] W2 is a duplicate sample of W78.
[f] NA = Not analyzed.
[g] MPV is a duplicate sample of MPF(S).
[h] W3 is a duplicate sample of MPL.

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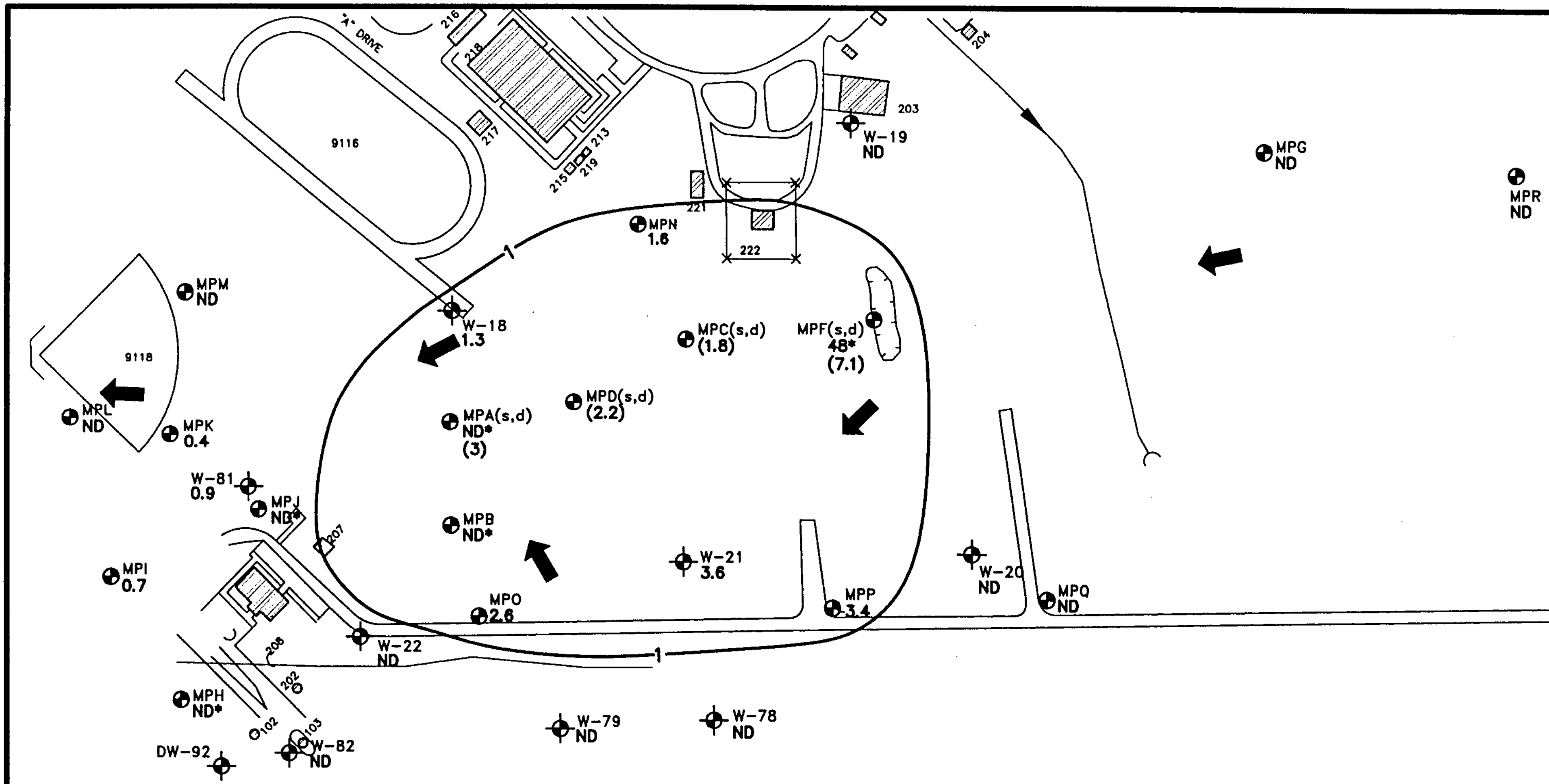

LEGEND

MPB MONITORING POINT NUMBER AND LOCATION

W-78 MONITORING WELL NUMBER AND LOCATION

s,d SHALLOW AND DEEP MONITORING POINT PAIR

* DATA FROM PERCHED GROUNDWATER ($\mu g/L$)

( ) DATA FROM DEEP MONITORING POINT ($\mu g/L$)

1 INFERRED LINE OF EQUAL TOTAL BTEX CONCENTRATION ($\mu g/L$)

INFERRED GROUNDWATER FLOW DIRECTION

N

0 125 250

FEET

FIGURE 4.3

AREAL EXTENT OF DISSOLVED TOTAL BTEX NOVEMBER 1996

Site LF-06 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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compounds also contained BTEX. 1,2,3,4-TEMB was detected in samples from 7 wells and points, with concentrations ranging from 0.5 μg/L to 5.7 μg/L. In general, TEMB was detected in wells in which BTEX were detected, but at 2 points [MPA(s) and MPB], TEMB was detected but BTEX were not. Both of these points are screened in perched zones. TVH were detected at one location. At MPF(s), the TVH concentration was 0.6 milligrams per liter (mg/L).

The fuel hydrocarbon data do not provide a clear indication of the source of contamination, but do suggest some possible source areas. The strongest indication of a source area is provided by the BTEX concentrations detected in MPF(s). That point was installed at the edge of a former disposal trench (see Figures 2.1 and 3.3, and the boring logs in Appendix A). Given the observed groundwater flow direction (roughly east to west), a source may also be present in the vicinity of MPP and W-21.

4.3.2 Chlorinated Ethenes

Chlorinated ethenes detected in groundwater at LF-06 include TCE, DCE, and VC. Data for chlorinated ethenes and other chlorinated compounds are presented in Table 4.3. Distributions of *cis*-1,2-DCE and 1,1-DCE are shown on Figure 4.4; the VC distribution is presented on Figure 4.5. TCE is not shown because it was detected in only 3 wells, and PCE was not detected in any samples.

As measured in November 1996, TCE concentrations detected in groundwater ranged from 0.68J μg/L at MPO to 7.4 μg/L at W-21 and 1.1 μg/L at MPM. Of these detections, the only one exceeding the MCL of 5 μg/L was the 7.4 μg/L detected at W-21. The detection of TCE at W-21 suggests that there may be a source of TCE associated with the apparent source of fuel hydrocarbons in that area. MPO is downgradient of W-21, so the detection of TCE at that point is likely related to the same source as the TCE detected at W21. The source of TCE at MPM is not clear, although other chlorinated compounds have been detected there (although BTEX have not).

TABLE 4.3
GROUNDWATER QUALITY DATA SUMMARY
FOR CHLORINATED VOCs
SITE LF-06 RNA TS
COLUMBUS AFB, MISSISSIPPI

Sample ID	Date Sampled	Vinyl Chloride (µg/L[a])	Chloro-ethane (µg/L)	1,1-DCE (µg/L)	Dichloro-methane (µg/L)	trans-1,2-DCE (µg/L)	1,1-DCA (µg/L)	cis-1,2-DCE (µg/L)	1,1,1-TCA (µg/L)	TCE (µg/L)	Chloro-benzene (µg/L)	1,3-DCB (µg/L)	1,2-DCB (µg/L)
W18	11/15/96	4.9	ND[b]	ND	ND	ND	ND	1.3	ND	ND	13	ND	0.78 J[c]
W19	11/17/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
W20	11/14/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
W21	11/14/96	10	ND	ND	0.43 J	ND	0.81 J	14.0	ND	7.4	13	ND	1.9
W22	11/13/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
W1[d]	11/13/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
W78	11/14/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
W2[e]	11/14/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
W79	11/15/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
W81	11/13/96	4.8	ND	ND	ND	ND	ND	ND	ND	ND	6.5	ND	0.49 J
W82	11/15/96	ND	ND	1.4	ND	ND	ND	ND	0.73 J	ND	ND	ND	ND
MPA(S)	11/17/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MPA(D)	11/17/96	6.6	ND	ND	ND	ND	1.2	0.44 J X[f]	ND	ND	20	ND	0.88 J
MPB	11/18/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MPC(S)	11/17/96	2.0 J[d]	1.3 J	ND	ND	ND	1.2	0.78 J	ND	ND	14	ND	0.87 J
MPC(D)	11/17/96	3.0	ND	ND	ND	ND	ND	2.3	ND	ND	2.3	ND	ND
MPD(D)	11/17/96	4.2	ND	ND	ND	ND	ND	ND	ND	ND	13	ND	0.8 J
MPF(S)	11/18/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	200 E[g]	ND	ND
MPV[h]	11/18/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	190 E	4.5	5.2
MPF(D)	11/17/96	1.7 J	ND	ND	ND	ND	ND	ND	ND	ND	6.1	ND	ND
MPG	11/18/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MPH	11/15/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MPI	11/15/96	3.4	ND	ND	ND	ND	ND	1.8	ND	ND	ND	ND	ND
MPJ	11/17/96	2.1 J	2.1 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MPK	11/15/96	3.0	ND	ND	ND	ND	ND	ND	ND	ND	6.1	ND	0.55 J
MPL	11/15/96	2.1 J	ND	ND	ND	ND	ND	ND	ND	ND	3.7	ND	ND
W3[i]	11/18/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MPM	11/13/96	ND	ND	2.7	ND	ND	ND	ND	3.8	1.1	ND	ND	ND
MPN	11/17/96	2.4 J	ND	ND	ND	ND	ND	7.2	ND	ND	23	ND	11
MPO	11/14/96	8.0	ND	ND	1.0	ND	0.44 J	15.0	ND	0.68 J	1.6 J	ND	ND
MPP	11/14/96	9.0	ND	ND	0.49 J	ND	ND	7.5	ND	ND	2.3	ND	0.74 J
MPQ	11/14/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MPR	11/17/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

[a] µg/L = micrograms per liter.
[b] ND = Analyte not detected.
[c] J = Estimated value.
[d] W1 is a duplicate sample of W22.
[e] W2 is a duplicate sample of W78.
[f] X = Not confirmed by mass spectrometer.
[g] E = Extrapolated value.
[h] MPV is a duplicate sample of MPF(S).
[i] W3 is a duplicate sample of MPL.

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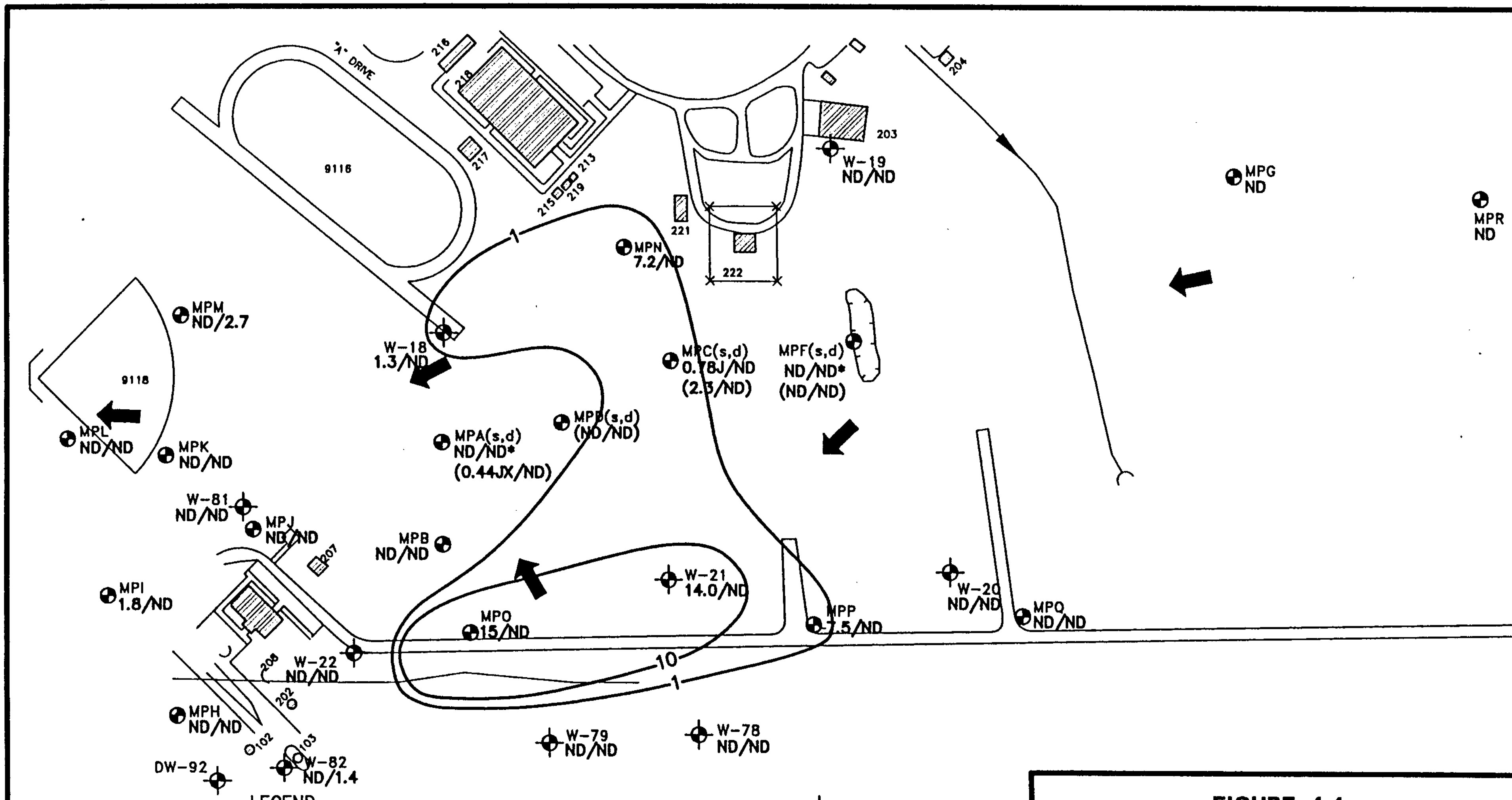

LEGEND

MPB MONITORING POINT NUMBER AND LOCATION

W-78 MONITORING WELL NUMBER AND LOCATION

s,d SHALLOW AND DEEP MONITORING POINT PAIR

* DATA FROM PERCHED GROUNDWATER (µg/L)

( ) DATA FROM DEEP MONITORING POINT (µg/L)

1 INFERRED LINE OF EQUAL cis-1,2-DCE CONCENTRATION (µg/L)

INFERRED GROUNDWATER FLOW DIRECTION

FIGURE 4.4

cis-1,2-DCE/1,1-DCE IN GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site LF-06 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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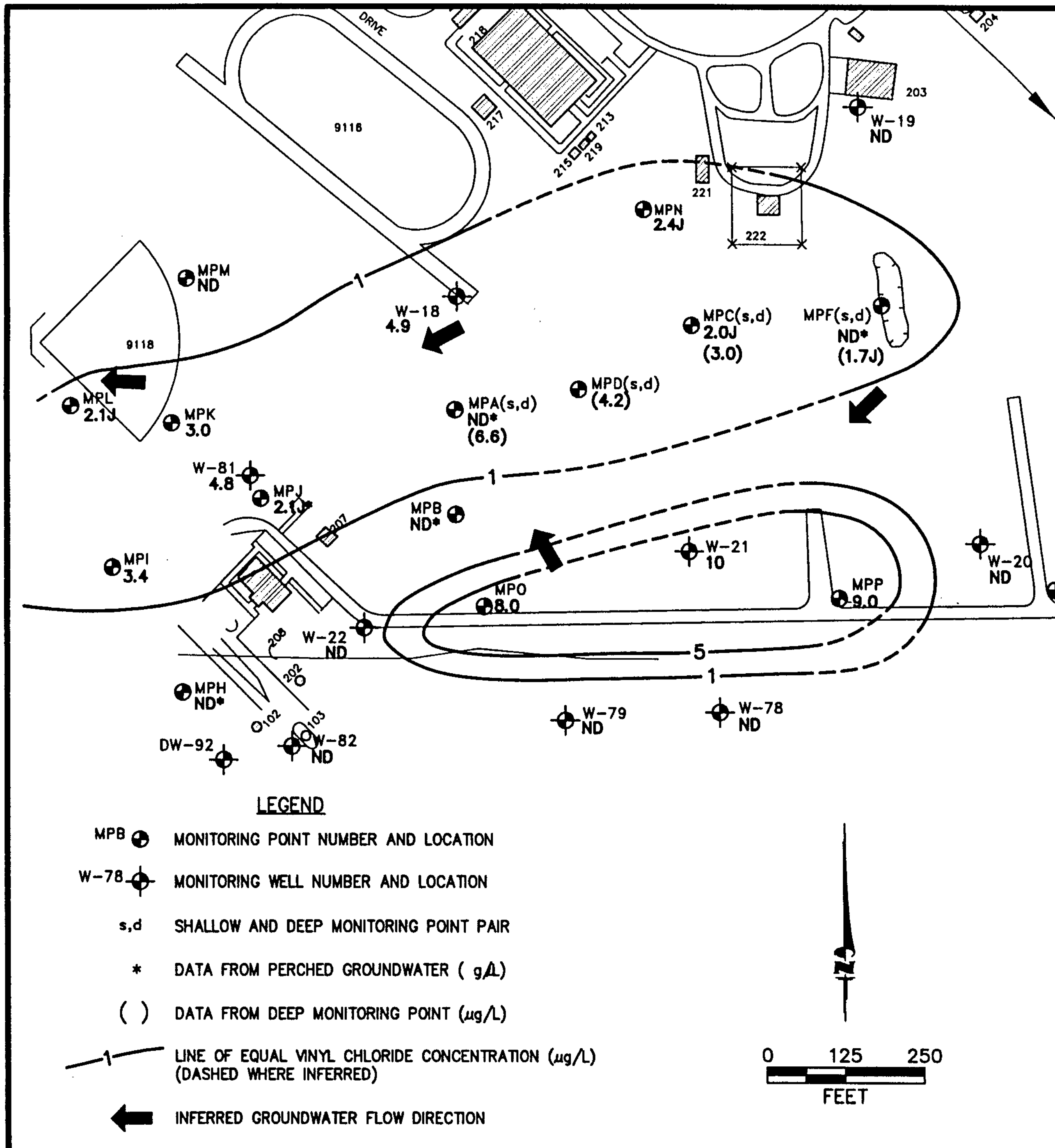

FIGURE 4.5

VINYL CHLORIDE IN GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site LF-06 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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cis-1,2-DCE was detected at several wells (Figure 4.4), but the highest detected concentration was 15 μg/L at MPO. This does not exceed the MCL of 70 μg/L. The two locations with the highest concentrations of *cis*-1,2-DCE coincide with the TCE detections at W-21 and MPO, and the third highest concentration (7.5 μg/L) was detected at MPP (near the suspected W-21 source area). A concentration of 1.8 μg/L was also detected well downgradient of MPO, at MPI. In addition, another apparent plume of *cis*-1,2-DCE was detected in MPN and downgradient at W-18. The concentration at MPN was 7.2 μg/L, while the concentration at W-18 was 1.3 μg/L, suggesting that a source area may be present in the vicinity of MPN. Also, concentrations of 0.78J and 2.3 μg/L were detected in MPC(s) and MPC(d), respectively; these wells are downgradient of the possible source area near MPF.

At all wells/points sampled, no *trans*-1,2-DCE was detected. This trend is what would be expected if TCE is being degraded to DCE via reductive dehalogenation. As noted before, under the influence of biodegradation, *cis*-1,2-DCE is a more common daughter product than the other DCE isomers. Furthermore, the *trans* isomer is more common when DCE is used for commercial applications. The presence of *cis*-1,2-DCE is therefore a good indicator that the initial step of reductive dehalogenation of TCE is taking place in groundwater at LF-06.

1,1-DCE was detected in samples from 2 wells at LF-06. Concentrations of 1.4 μg/L and 2.7 μg/L were detected in samples from W-82 and MPM, respectively (Figure 4.4). These concentrations do not exceed the MCL of 7 μg/L. Neither TCE nor any other isomer of DCE were detected in these wells. This suggests that while 1,1-DCE could have been produced by reductive dehalogenation of TCE, it is more likely it came from another source. However, as will be discussed in Section 4.3.4, 1,1,1-TCA was also detected in both of these wells. This suggests that 1,1-DCE may be produced abiotically via dehydrohalogenation of 1,1,1-TCA.

The distribution of VC in site groundwater is shown on Figure 4.5. The 15 VC concentrations detected at the site range from 1.7J to 10 μg/L (Table 4.3). Generally, where detected, VC concentrations exceeded the MCL of 2 μg/L. The VC plumes appear to emanate from similar sources as those indicated by the BTEX, TCE, and DCE data, and the extents of the VC plumes are also similar to those indicated by the other contaminant data. In fact, VC was detected at all 9 locations where *cis*-1,2-DCE was detected. The presence of VC in groundwater is also a good indicator of the occurrence of reductive dehalogenation, because VC is typically a gas at most working temperatures [the boiling point of VC is about 13.5°C/7°F (Montgomery, 1996)]. Because of this, VC is not commonly used as a solvent, and is instead used for plastic manufacturing. In addition, the low boiling point indicates that when liquid VC is spilled, most of the mass is likely to volatilize before reaching groundwater unless there is a large-volume release.

4.3.3 Chlorinated Ethanes

Chlorinated ethanes detected in groundwater at LF-06 include 1,1,1-TCA, 1,1-DCA, and CA (Table 4.3). The distribution of these compounds is shown on Figure 4.6. Relatively low concentrations of these compounds were detected, with the maximum concentration being 3.8 μg/L of 1,1,1-TCA at MPM. 1,1,1-TCA and 1,1-DCA concentrations did not exceed their respective MCLs of 200 μg/L and 3,500 μg/L. In general, chlorinated ethanes were detected in the same wells as the chlorinated ethenes.

1,1,1-TCA was detected in only two wells/points (W-82 and MPM). As discussed in section 4.3.3, these are the only wells in which 1,1-DCE was detected. This suggests that 1,1,1-TCA is being dehydrohalogenated to 1,1-DCE in those locations. Also, the absence of 1,1,1-TCA and the presence of 1,1-DCA and CA in other wells that also contained BTEX and chlorinated ethenes suggests that reductive dechlorination is ongoing within the area of the BTEX plume. Additionally, 1,1-DCA is not commonly used as a solvent, whereas 1,2-DCA is; therefore, the presence of 1,1-DCA rather than 1,2-DCA further suggests that reductive dechlorination of 1,1,1-TCA is ongoing in the central portion of the

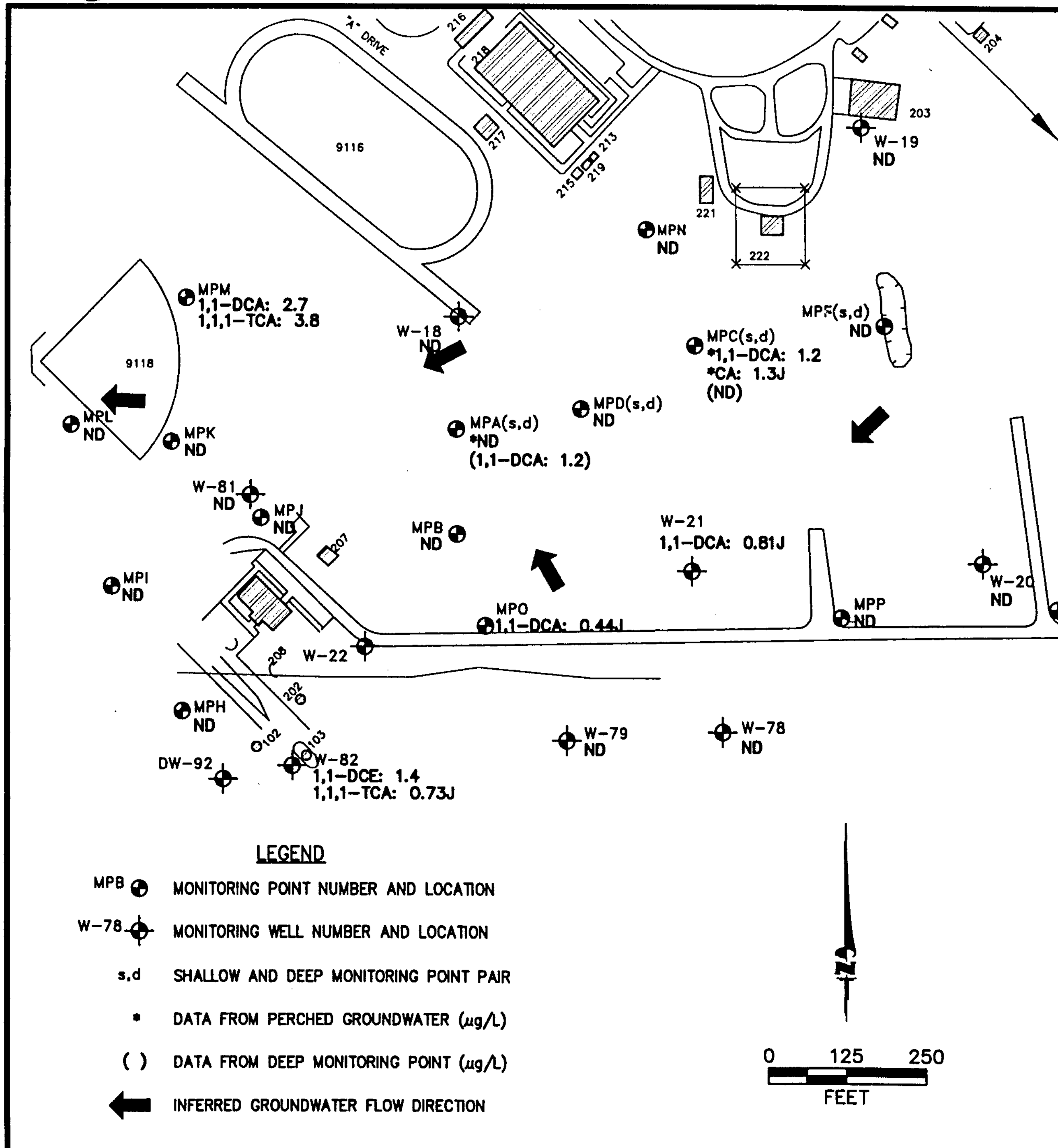

FIGURE 4.6

CHLORINATED ETHANES AND 1,1-DCE IN GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site LF-06 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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LF-06 contaminant plumes. Reductive dehalogenation could account for the absence of 1,1,1-TCA in the central plume area, while in the periphery wells (where conditions are likely less reducing), TCA is not reductively dechlorinated but instead reacts abiotically to form 1,1-DCE. The abiotic reaction is relatively slow compared to reductive dehalogenation, which could explain why some 1,1,1-TCA remains in the groundwater at the plume periphery.

4.3.4 Chlorobenzenes

Chlorobenzenes detected in groundwater at LF-06 include 1,2-DCB, 1,3-DCB, and CB (Table 4.3). These compounds generally were detected in the same wells as the other contaminants, and a CB plume appears to be originating from the vicinity of MPF(s) and migrating to the west (Figure 4.7). Detected CB concentrations ranged from 1.6J µg/L to 200E µg/L, with all but one concentration in the range of 1.6J to 23 µg/L. The highest CB concentration (200 µg/L) was detected in MPF(s), and this is the only one of the chlorobenzene compounds present in a concentration exceeding MCLs. The MCL for CB is 100 µg/L, and the MCL for both 1,2-DCB and 1,3-DCB is 600 µg/L . Of the DCBs, 1,2-DCB is the most commonly detected; 1,3-DCB was detected only in MPF(s), at a concentration of 4.2 µg/L. 1,2-DCB was detected only in wells that also contained CB, and 1,2-DCB concentrations ranged from 0.49J µg/L to 11 µg/L.

It is possible that some DCB is being reductively dechlorinated to CB in the center of the plume area where conditions may be the most reducing. However, it is more likely that both CB and DCB are being utilized aerobically as electron donors/substrates in the same manner as the BTEX compounds. This activity is most likely taking place at the plume fringes where aerobic conditions are prevalent, but may also take place throughout the plume when precipitation events briefly introduce oxygenated recharge to the water table.

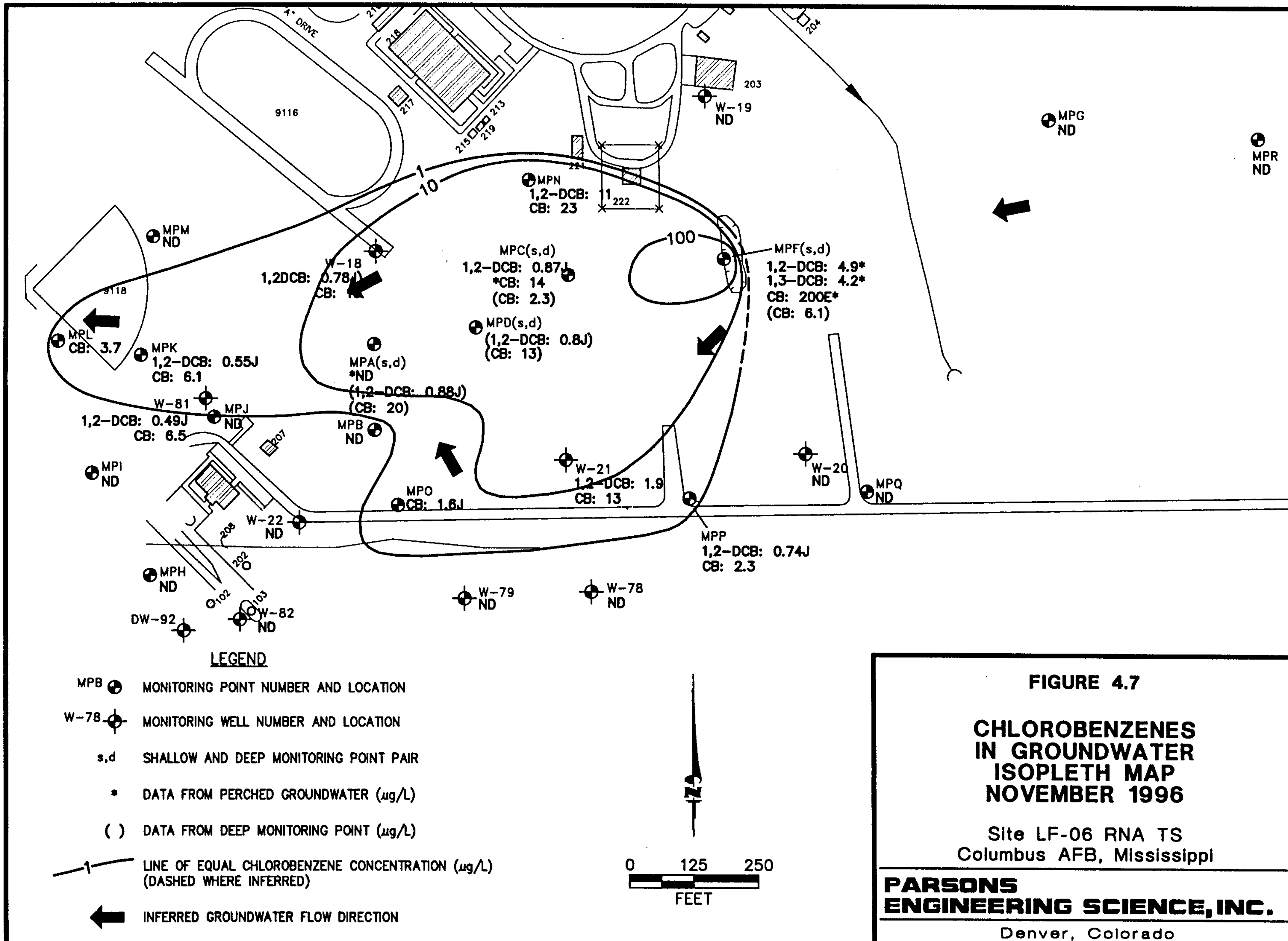

FIGURE 4.7

CHLOROBENZENES IN GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site LF-06 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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4.3.5 Other Chlorinated Compounds

One other chlorinated compound was detected in groundwater at LF-06. Dichloromethane (DCM, also known as methylene chloride) was detected at concentrations of 0.43J µg/L in W-21, 1.0 µg/L in MPO, and 0.49J µg/L in MPP. These points are all along the southern boundary of the landfill area, and these detections may be indicative of a source of DCM in the vicinity of MPP. The detected concentrations do not exceed the MCL of 5 µg/L.

DCM is used as a solvent, and is also an ingredient in paints and varnishes (Montgomery, 1996). It is commonly used as a laboratory solvent and is often present in samples due to laboratory contamination, and this might explain detections of DCM in site groundwater. However, given that the three wells/points in which DCM was detected lie roughly along a flowpath and coincide with locations where other chlorinated solvents were detected, it seems more likely that DCM is present in site groundwater due to a source in the vicinity of MPP and W-21.

4.3.6 Chloride

Chloride ions are removed from chlorinated solvents and enter solution during biodegradation, whether via reductive dehalogenation or aerobic oxidation . Therefore, chloride concentrations in groundwater should increase above background levels in areas where reductive dehalogenation or aerobic biodegradation are taking place. Chloride concentrations are presented in Table 4.4, and Figure 4.8 shows the distribution of chloride in shallow groundwater at the site. Background chloride concentrations (measured in wells without contamination in shallow site groundwater range from about 2.9 mg/L to about 20 mg/L, with one concentration (at MPR) of 322.5 mg/L. It is not clear what is responsible for this anomalous concentration. Most background chloride concentrations are less than 8.7 mg/L. Chloride concentrations within the boundaries of the chlorinated solvent plumes generally are elevated slightly above background, with a maximum concentration of 182.5

TABLE 4.4
GROUNDWATER ELECTRON ACCEPTORS/BYPRODUCTS
ANALYTICAL DATA
SITE LF-06 RNA TS
COLUMBUS AFB, MISSISSIPPI

Sample ID	Date Sampled	Dissolved Oxygen (mg/L[a])	Carbon Dioxide (mg/L)	Lab Chloride (mg/L)	Field Chloride (mg/L)	Lab Sulfate (mg/L)	Field Sulfate (mg/L)	Lab NO_2^- (mg/L)	Field NO_2^- (mg/L)	Lab NO_3^- (mg/L)	Field NO_3^- (mg/L)	Ferrous Iron (mg/L)	Mn^+ (mg/L)	NH_4^+ (mg/L)	Methane (mg/L)
W18	11/15/96	0.16	250	16.8	21	8.9	16.11	ND[b]	ND	ND	0.2	4.77	1.7	2	0.11
W19	11/17/96	2.48	130	2.3	2.9	11.0	15.03	ND	0.003	0.81	1.0	0.01	ND	ND	ND
W20	11/14/96	0.64	90	6.7	7.9	0.41	0.49	ND	0.001	2.5	2.0	ND	0.1	ND	ND
W21	11/14/96	0.17	400	54.1	58	ND	1.46	ND	0.017	0.38	0.5	0.01	0.1	ND	2.7
W22	11/13/96	0.56	130	3.8	4.8	11.0	13.73	ND	0.004	ND	0.7	0.02	0.3	ND	ND
W1[c]	11/13/96	NA	NA	3.7	NA	11.6	NA	ND	NA	ND	NA	NA	NA	NA	ND
W78	11/14/96	0.29	180	17.5	19.5	50.6	48.97	ND	0.002	ND	0.4	0.35	ND	ND	0.021
W79	11/15/96	2.88	90	3.7	5.0	1.3	1.19	ND	0.002	1.4	1.2	0.01	ND	ND	ND
W81	11/13/96	0.20	500	14.4	22.5	3.8	12.43	ND	ND	ND	ND	4.87	1.0	> 10	0.70
W82	11/15/96	2.03	160	5.5	6.5	1.5	2.22	ND	0.001	1.9	2.2	0.01	0.1	ND	ND
MPA(s)	11/17/96	0.62	250	4.2	5.3	119	130.55	ND	0.001	ND	0.4	22.75	0.8	4	0.85
MPA(d)	11/17/96	0.96	350	18.4	18.8	1.3	2.12	ND	0.002	ND	0.4	1.29	0.8	ND	0.31
MPB	11/18/96	1.12	250	2.8	3.2	48.9	51.7	ND	0.019	3.2	1.3	1.77	0.4	1	4.7
MPC(s)	11/17/96	1.94	350	13.2	17.8	4.0	4.22	ND	ND	ND	0.5	75.0	2.0	> 10	1.9
MPC(d)	11/17/96	0.63	350	36.6	46	ND	1.41	ND	0.002	0.39	0.5	0.96	1.3	ND	0.35
MPD(d)	11/17/96	0.15	300	7.2	8	4.8	1.68	ND	0.002	ND	0.2	0.62	0.8	ND	0.24
MPF(s)	11/18/96	0.22	500	6.4	8.5	13.4	6.51	ND	ND	ND	3.5	22.15	0.7	> 10	6.5
MPF(d)	11/17/96	0.45	400	22.4	27.5	1.0	6.32	ND	ND	ND	0.5	95.5	14.4	> 10	0.44
MPG	11/18/96	NA	40	3.3	8.6	8.8	19.48	ND	0.001	ND	ND	2.94	ND	0.1	ND
MPH	11/15/96	5.09	100	3.9	6.5	14.9	15.78	ND	0.001	0.61	1.0	5.45	ND	0.8	ND
MPI	11/15/96	0.20	250	51.2	10.9	1.4	1.68	ND	ND	ND	0.2	2.10	0.1	ND	0.26
MPJ	11/17/96	2.82	150	23.4	26	0.36	1.51	ND	0.002	ND	0.7	7.0	ND	0.1	0.017
MPK	11/15/96	0.18	500	18.9	27.5	3.7	2.87	ND	0.001	ND	0.8	71.75	5.4	> 10	0.22
MPL	11/15/96	0.28	250	11.3	12.8	5.6	2.43	ND	ND	ND	6.7	6.40	9.1	1	0.21
MPM	11/13/96	4.88	50	6.5	9.6	0.27	1.73	ND	ND	1.3	1.5	2.01	0.1	0.3	ND
MPN	11/17/96	0.32	500	23.1	132.5	2.3	3.95	ND	ND	ND	0.4	94.25	7.4	> 10	0.059
MPO	11/14/96	0.26	300	177.0	182.5	6.0	2.97	ND	ND	0.35	0.8	0.71	ND	ND	1.8
MPP	11/14/96	0.27	300	44.2	8.7	2.2	0.59	ND	0.001	0.073	0.1	2.10	ND	ND	2.7
MPQ	11/14/96	4.78	50	70.7	78.0	0.34	3.14	ND	0.001	1.5	1.1	3.16	ND	ND	ND
MPR	11/17/96	0.18	160	271.0	322.5	0.88	1.68	ND	ND	0.3	0.8	6.55	1.1	1	0.012

[a] mg/L = milligrams per liter.
[b] ND = Analyte not detected.
[c] Duplicate sample of W22.

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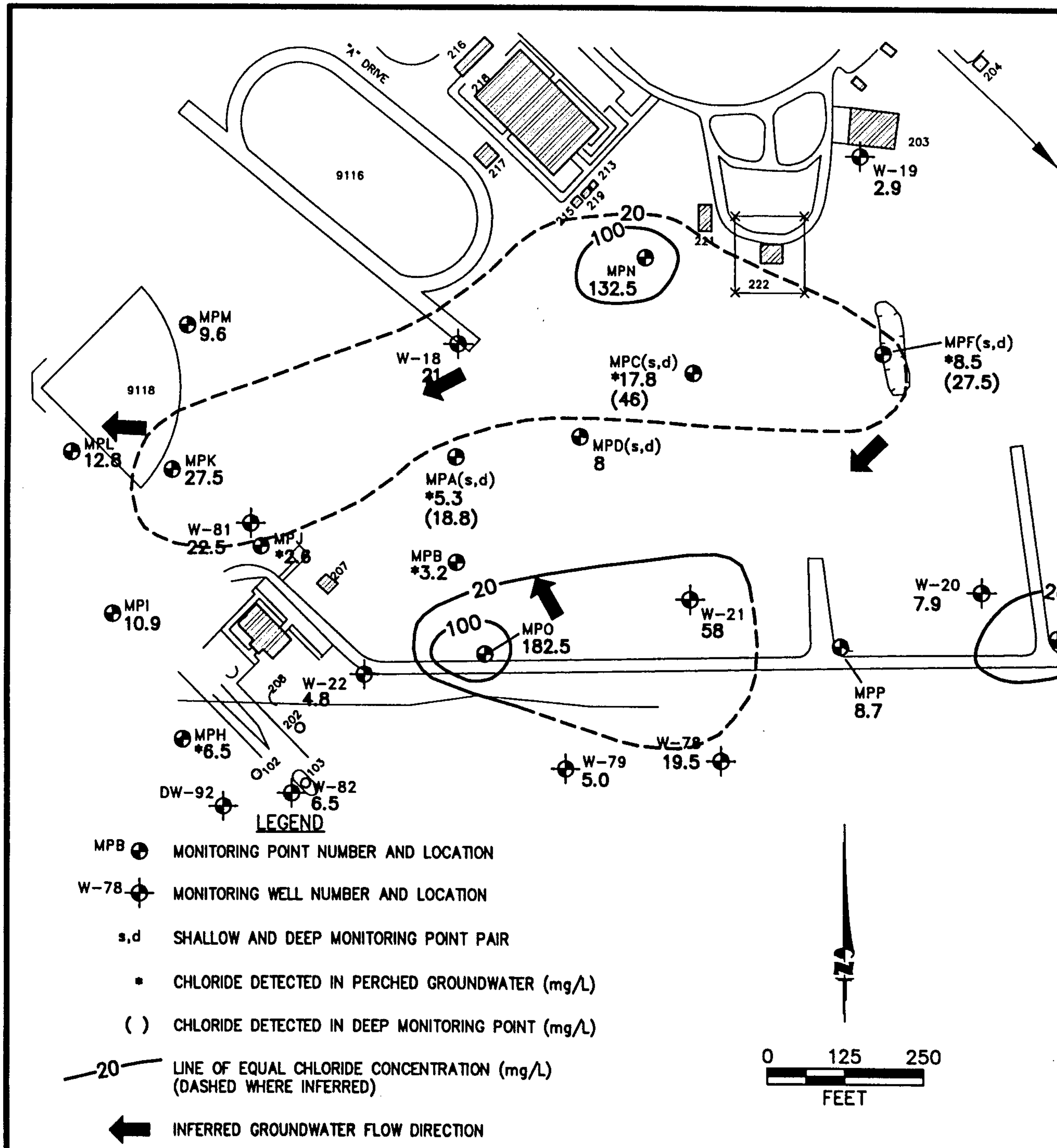


FIGURE 4.8

CHLORIDE IN GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site LF-06 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

mg/L. Most chloride concentrations within the areas where biodegradation is indicated by chemical and geochemical data are greater than 20 mg/L.

In conjunction with the distributions of CAHs shown on Figures 4.4 through 4.6, the elevated chloride concentrations observed at LF-06 are a good indication that CAHs are undergoing microbially mediated degradation. Given the presence of daughter products such as *cis*-1,2-DCE, VC, 1,1-DCA, and CA, it is likely that some of the chloride is a product of reductive dehalogenation. However, because chloride is also released during consumption of solvents as substrates, some of the chloride plume may be related to these reactions. It is also possible that landfill materials may also be contributing chloride to the groundwater. However, the presence of daughter products strongly suggests that some of the chloride is indeed derived from solvent biodegradation.

4.4 ADDITIONAL EVIDENCE OF BIODEGRADATION

In addition to the distribution of contaminants and daughter products, other evidence can be used to support the interpretation that biodegradation of fuel hydrocarbons and chlorinated solvents is ongoing at LF-06. As noted in Section 4.2, comparing concentrations and distributions of electron donors, electron acceptors, and byproducts of microbially mediated reactions can help indicate what types of processes are operating at a site. In addition, other geochemical parameters, including redox potential, alkalinity, and other changes in groundwater chemistry can also provide supporting evidence. Other data, such as volatile fatty acid concentrations, also can be useful for interpreting and confirming biodegradation mechanisms.

4.4.1 Electron Donors, Native Electron Acceptors, and Byproducts

When investigating the biodegradation of hydrocarbons, it is also necessary to look at the distribution of other compounds that are used in the microbially mediated reactions that facilitate contaminant degradation. The distribution of other potential electron donors (besides contaminants), such as dissolved organic carbon (native or from leachate), is useful for evaluating the feasibility of reductive dehalogenation or cometabolism (i.e.,

biodegradation reactions involving another substrate). Moreover, electron acceptor and metabolic byproduct data will further indicate what processes may be facilitating contaminant degradation.

4.4.1.1 Organic Carbon in Groundwater

Dissolved organic carbon also can act as a source of electron donors during the reductive dehalogenation of CAHs. Dissolved TOC concentrations can be used as an indicator of the presence of such native carbon compounds in wells outside of the area containing dissolved contamination (anthropogenic organic compounds, such as CAHs, petroleum hydrocarbons, or landfill leachate also are measured by the TOC analytical method).

TOC dissolved in groundwater was measured in some of the groundwater samples collected in November 1996. These concentrations are presented in Table 4.5. Dissolved TOC concentrations detected in shallow groundwater at LF-06 range from 2.1 mg/L to 34.7 mg/L. The highest concentration was measured in MPO and may reflect the presence of contamination, including landfill leachate. Elsewhere, the TOC concentrations did not exceed 5.6 mg/L. Most of these other concentrations were measured in wells/points that are near the fringes of the contaminant plumes and thus are likely to represent background concentrations.

These background concentrations of dissolved TOC are noteworthy because they represent additional organic matter that is available for use as a substrate in biodegradation reactions. The background concentrations likely represent compounds dissolved from dispersed organic matter throughout the aquifer, and possibly some landfill leachate. In addition to the soil TOC, this carbon source should provide a continuing source of electron donors to be used in microbial redox reactions. As discussed in Section 4.4.1.2, other

TABLE 4.5
GROUNDWATER GEOCHEMICAL INDICATORS
ANALYTICAL DATA
SITE LF-06 RNA TS
COLUMBUS AFB, MISSISSIPPI

Sample ID	Date Sampled	Temp (°C)	pH	Conductivity (µS/cm[a])	Total Field Alkalinity (mg/L[b])	Total Laboratory Alkalinity (mg/L)	Total Redox Potential (mV[c])	TOC (mg/L)
W18	11/15/96	19.3	5.6	245	68	NA[d]	100	NA
W19	11/17/96	19.6	5.2	85	21	NA	284	NA
W20	11/14/96	17.6	4.5	63	3	< 5	254	NA
W21	11/14/96	16.9	4.3	240	0	< 5	216	4.6
W22	11/13/96	20.2	4.6	62	0	< 5	175	NA
W1[e]	11/13/96	NA	NA	NA	NA	< 5	NA	NA
W78	11/14/96	18.7	4.5	198	4	< 5	184	2.1
W79	11/15/96	16.9	4.7	44	7	NA	181	NA
W81	11/13/96	20.0	6.2	624	322	298	-65	NA
W82	11/15/96	20.8	4.4	58	6	NA	233	NA
MPA(s)	11/17/96	20.3	6.8	824	290	NA	-103	NA
MPA(d)	11/17/96	20.1	5.7	118	5	NA	-68	NA
MPB	11/18/96	19.8	5.0	493	352	NA	1	NA
MPC(s)	11/17/96	17.1	6.5	491	230	NA	-44	NA
MPC(d)	11/17/96	17.8	5.4	177	15	NA	-300	NA
MPD(d)	11/17/96	18.0	5.0	115	35	NA	96	NA
MPF(s)	11/18/96	17.5	6.3	820	425	NA	-122	NA
MPF(d)	11/17/96	18.4	6.5	620	255	NA	-15	NA
MPG	11/18/96	17.8	6.5	85	18	NA	-71	NA
MPH	11/15/96	18.3	5.4	78	10	NA	75	NA
MPI	11/15/96	20.8	5.1	230	11	NA	114	ND[f]
MPJ	11/17/96	19.9	5.7	129	13	NA	-60	NA
MPK	11/15/96	20.5	6.2	504	215	NA	-1	5.6
MPL	11/15/96	20.5	5.7	268	97	NA	46	NA
MPM	11/13/96	18.7	5.4	62	6	7.1	660	NA
MPN	11/17/96	18.3	6.8	599	245	NA	-55	NA
MPO	11/14/96	18.8	4.8	634	19	19.5	87	34.7
MPP	11/14/96	18.8	4.7	208	10	10	67	3.4
MPQ	11/14/96	17.5	6.0	410	19	21.1	158	NA
MPR	11/17/96	19.2	4.9	750	6	NA	56	NA

[a] µS/cm = microSiemens per centimeter.
[b] mg/L = milligrams per liter.
[c] mV = millivolts.
[d] NA = Not analyzed.
[e] Duplicate sample of W22.
[f] ND = Analyte not detected.
Note: TOC = total organic carbon.

geochemical evidence indicates that microbial consumption of the carbon is occurring within the contaminant plumes at LF-06.

4.4.1.2 Inorganic Chemistry

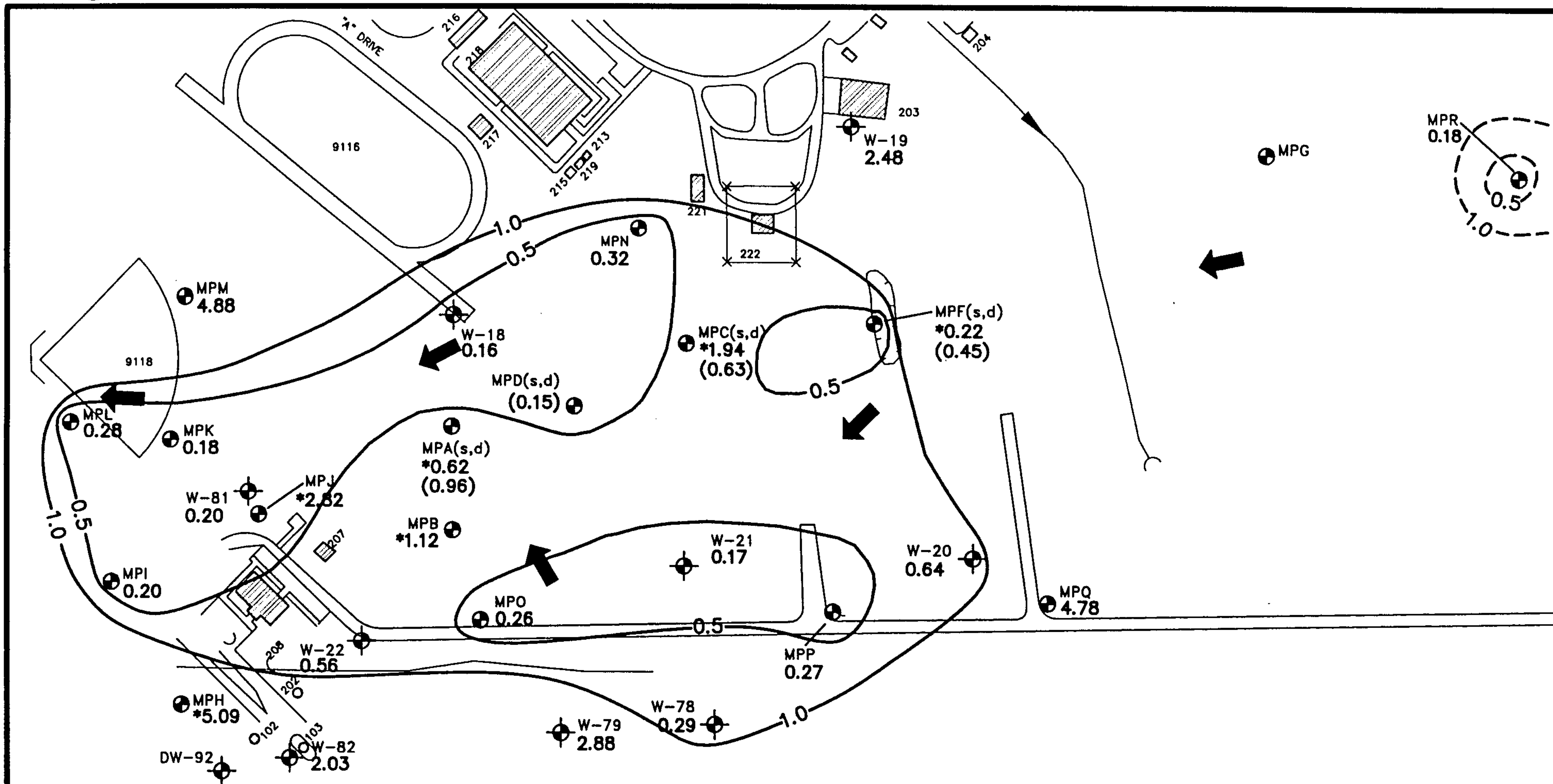
An interpretation of inorganic groundwater geochemistry, including isopleth maps for typical electron acceptors, can provide information regarding the relative importance of various biodegradation mechanisms and whether the conditions at the site are favorable for reductive dehalogenation of chlorinated compounds. Numerous geochemical parameters were evaluated in site groundwater samples. Analytical results for geochemical parameters measured in site samples are presented in Tables 4.4 and 4.5. The following paragraphs discuss those parameters that are most useful in the evaluation of site biodegradation processes.

4.4.1.2.1 Dissolved Oxygen

DO concentrations were measured at monitoring wells and points during the November 1996 sampling event. Concentrations ranged from 0.15 to 5.1 mg/L (Table 4.4), with the highest concentrations measured in wells/points outside of the area of the contaminant plumes. Within the plume area, concentrations were generally below 1.0 mg/L, except in some of the monitoring points screened in perched zones. Figure 4.9 illustrates DO concentrations at the site. The low concentrations of oxygen in the plume area relative to upgradient and crossgradient concentrations is a strong indication of biological activity in the plume area. Depletion of DO within the BTEX and chlorinated solvent plumes at LF-06 indicates that microbial activity stimulated by the presence of anthropogenic hydrocarbons (e.g., BTEX, chlorobenzenes, VC, DCA, DCE, or other components of landfill waste) is consuming DO and creating anaerobic conditions.

4.4.1.2.2 Nitrate/Nitrite

Concentrations of nitrate/nitrite [as nitrogen (N)] were measured in groundwater samples collected in November 1996. Table 4.4 summarizes measured nitrate/nitrite



LEGEND

MPB — MONITORING POINT NUMBER AND LOCATION

W-78 — MONITORING WELL NUMBER AND LOCATION

s,d — SHALLOW AND DEEP MONITORING POINT PAIR

* — DO DETECTED IN PERCHED GROUNDWATER (mg/L)

( ) — DO DETECTED IN DEEP MONITORING POINT (mg/L)

1.0 — INFERRED LINE OF EQUAL DO CONCENTRATION (mg/L)

INFERRED GROUNDWATER FLOW DIRECTION

N

0 125 250
FEET

FIGURE 4.9

DISSOLVED OXYGEN IN GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site LF-06 RNA TS
Columbus AFB, Mississippi

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Denver, Colorado

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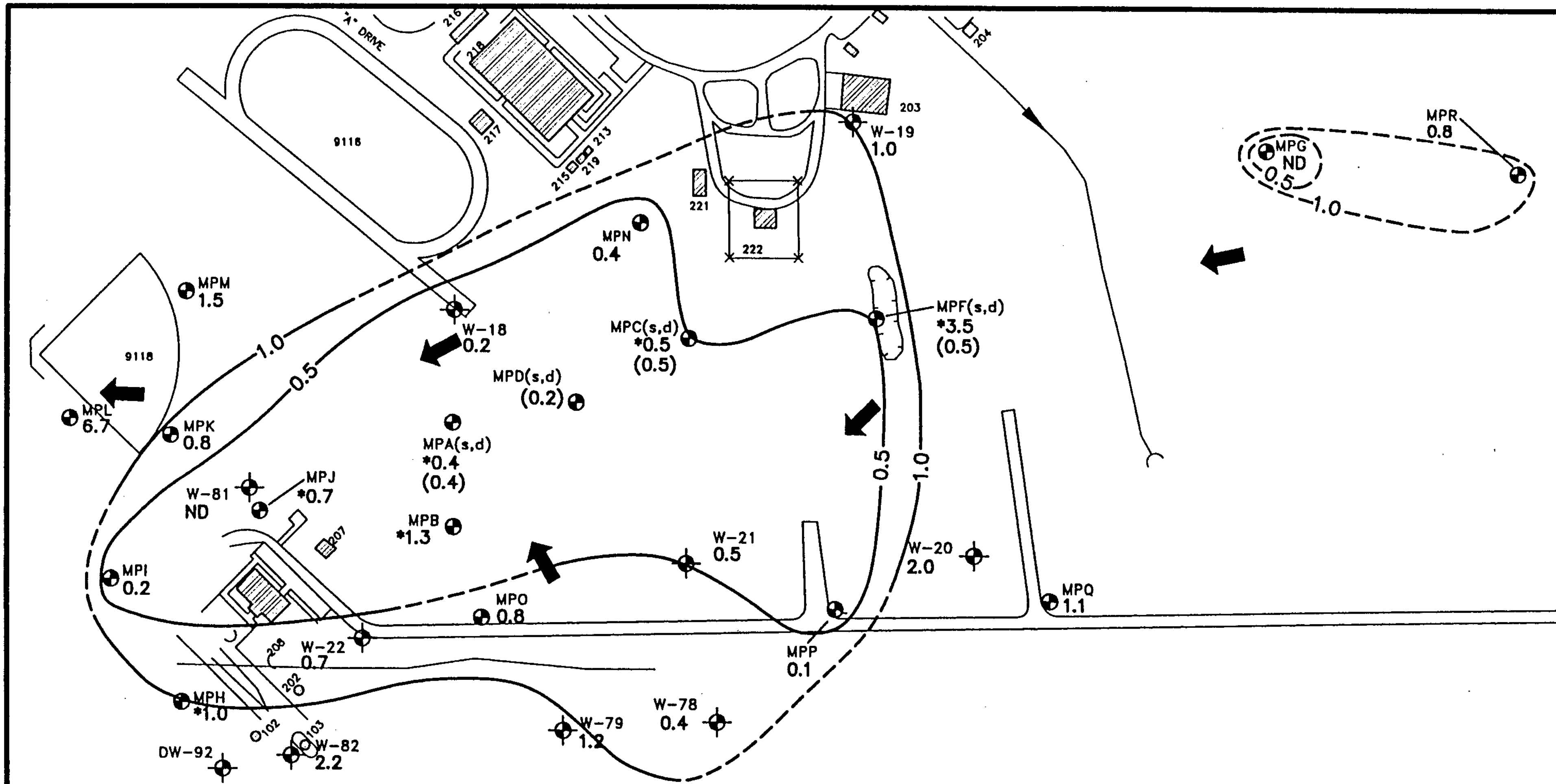
(as N) concentrations, and Figure 4.10 shows the distribution of nitrate/nitrite (as N) concentrations in site groundwater. Background concentrations range from about 1 mg/L to 6.7 mg/L, with most below 2.2 mg/L. Within the plume, nitrate concentrations are generally less than 0.5 mg/L, with some higher concentrations detected in perched groundwater or at the fringes. The area of reduced nitrate concentrations also coincides with the area of reduced DO concentrations, indicating that as DO is removed, microbes are utilizing nitrate as an electron acceptor for degradation of organic material (such as BTEX or native organic carbon).

4.4.1.2.3 Ferrous Iron

Ferrous iron [iron (II)] concentrations were measured in groundwater samples collected in November 1996. Table 4.4 summarizes ferrous iron concentrations. Measured ferrous iron concentrations range from 0.01 mg/L to 95.5 mg/L. Figure 4.11 shows the areal extent of ferrous iron in groundwater. Elevated ferrous iron concentrations coincide with the solvent and BTEX plumes. This suggests that ferric iron [iron (III)] hydroxide is being reduced to ferrous iron during biodegradation of native organic carbon, BTEX compounds, and possibly less-chlorinated solvents. Background levels of ferrous iron appear to range from below detection limits (0.05 mg/L) to about 3.0 mg/L, as measured at upgradient and crossgradient wells.

Recent evidence suggests that the reduction of ferric iron to ferrous iron cannot proceed at all without microbial mediation (Lovley and Phillips, 1988; Lovley *et al.*, 1991; Chapelle, 1993). None of the common organic compounds found in low-temperature (i.e., non-hydrothermal), neutral, reducing groundwater could reduce ferric oxyhydroxides to ferrous iron under sterile laboratory conditions (Lovley *et al.*, 1991). This means that the reduction of ferric iron requires microbial mediation by microorganisms with the appropriate enzymatic capabilities. Because the reduction of ferric iron cannot proceed without microbial intervention, the elevated concentrations of ferrous iron that were



LEGEND

MPB — MONITORING POINT NUMBER AND LOCATION

W-78 — MONITORING WELL NUMBER AND LOCATION

s,d — SHALLOW AND DEEP MONITORING POINT PAIR

* — NITRATE + NITRITE (as N in mg/L) DETECTED IN PERCHED GROUNDWATER

( ) — NITRATE + NITRITE (as N in mg/L) DETECTED IN DEEP MONITORING POINT

1.0 — INFERRED LINE OF EQUAL NITRATE + NITRITE (AS N) CONCENTRATION (mg/L) (DASHED WHERE INFERRED)

INFERRED GROUNDWATER FLOW DIRECTION

FIGURE 4.10

NITRATE + NITRITE (AS N) IN GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site LF-06 RNA TS
Columbus AFB, Mississippi

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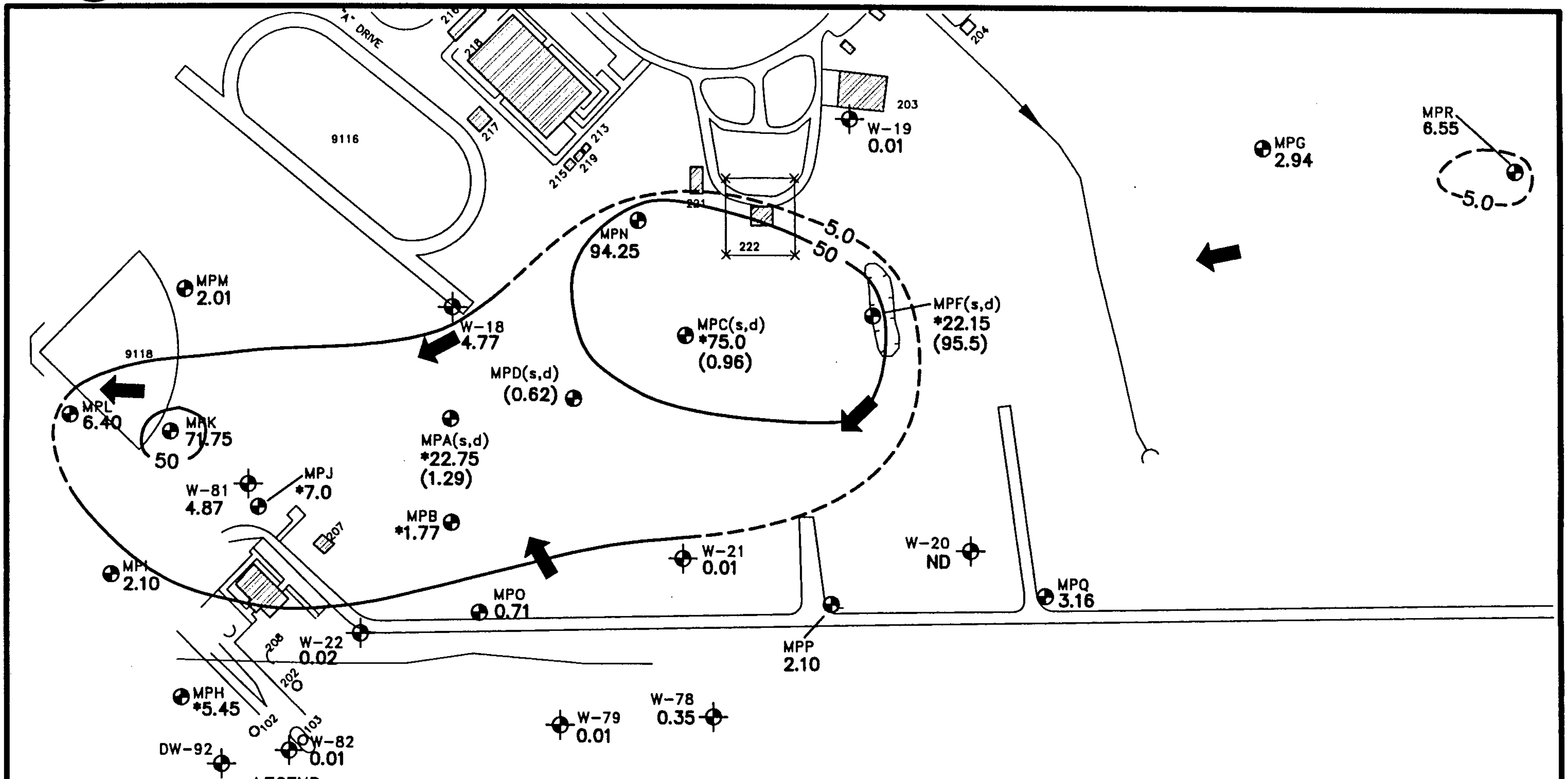
Denver, Colorado



LEGEND

MPB — MONITORING POINT NUMBER AND LOCATION

W-78 — MONITORING WELL NUMBER AND LOCATION

s,d — SHALLOW AND DEEP MONITORING POINT PAIR

* — FERROUS IRON DETECTED IN (mg/L) PERCHED GROUNDWATER

( ) — FERROUS IRON DETECTED IN (mg/L) DEEP MONITORING POINT

1 — LINE OF EQUAL FERROUS IRON CONCENTRATION (mg/L) (DASHED WHERE INFERRED)

INFERRED GROUNDWATER FLOW DIRECTION

FIGURE 4.11

FERROUS IRON IN GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site LF-06 RNA TS
Columbus AFB, Mississippi

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Denver, Colorado

measured in the contaminated groundwater at the site are very strong indicators of microbial activity.

4.4.1.2.4 Sulfate

Sulfate concentrations were measured in groundwater samples collected in November 1996. Sulfate concentrations in shallow groundwater at the site ranged from 0.16 mg/L to 49 mg/L (Table 4.4). In general, the highest sulfate concentrations (ranging from about 15 mg/L to about 49 mg/L) were detected in wells outside of the area of the BTEX and chlorinated solvent plumes (Figure 4.12). Within the plume area, nearly all sulfate concentrations ranged from 0.16 mg/L to about 3 mg/L. Some sulfate concentrations within the plume area were as high as 26 mg/L, but these were typically for samples collected from perched wells/points.

The area of decreased sulfate concentrations correlates well with chlorinated solvent and BTEX concentrations. It is therefore likely that sulfate reduction is an ongoing anaerobic biodegradation process at LF-06. This is important because when a system is sufficiently reducing that sulfate reduction occurs, conditions become more favorable for reductive halogenation of solvents as BTEX or other electron donors are consumed.

4.4.1.2.5 Methane in Groundwater

Methane concentrations were measured in groundwater samples collected in November 1996. Table 4.4 lists methane concentrations, which ranged from less than 0.005 mg/L to 6.5 mg/L at the site. Figure 4.13 shows the distribution of methane in shallow site groundwater. The area of elevated methane concentrations correlates well with the chlorinated solvent and BTEX plumes. The presence of methane in the plume area indicates that conditions are sufficiently reducing that petroleum hydrocarbons and native organic matter are being used to support methanogenesis. Further, the fact that methanogenesis is ongoing indicates that conditions in the plume area are highly reducing and therefore favorable for reductive dehalogenation of chlorinated solvents.

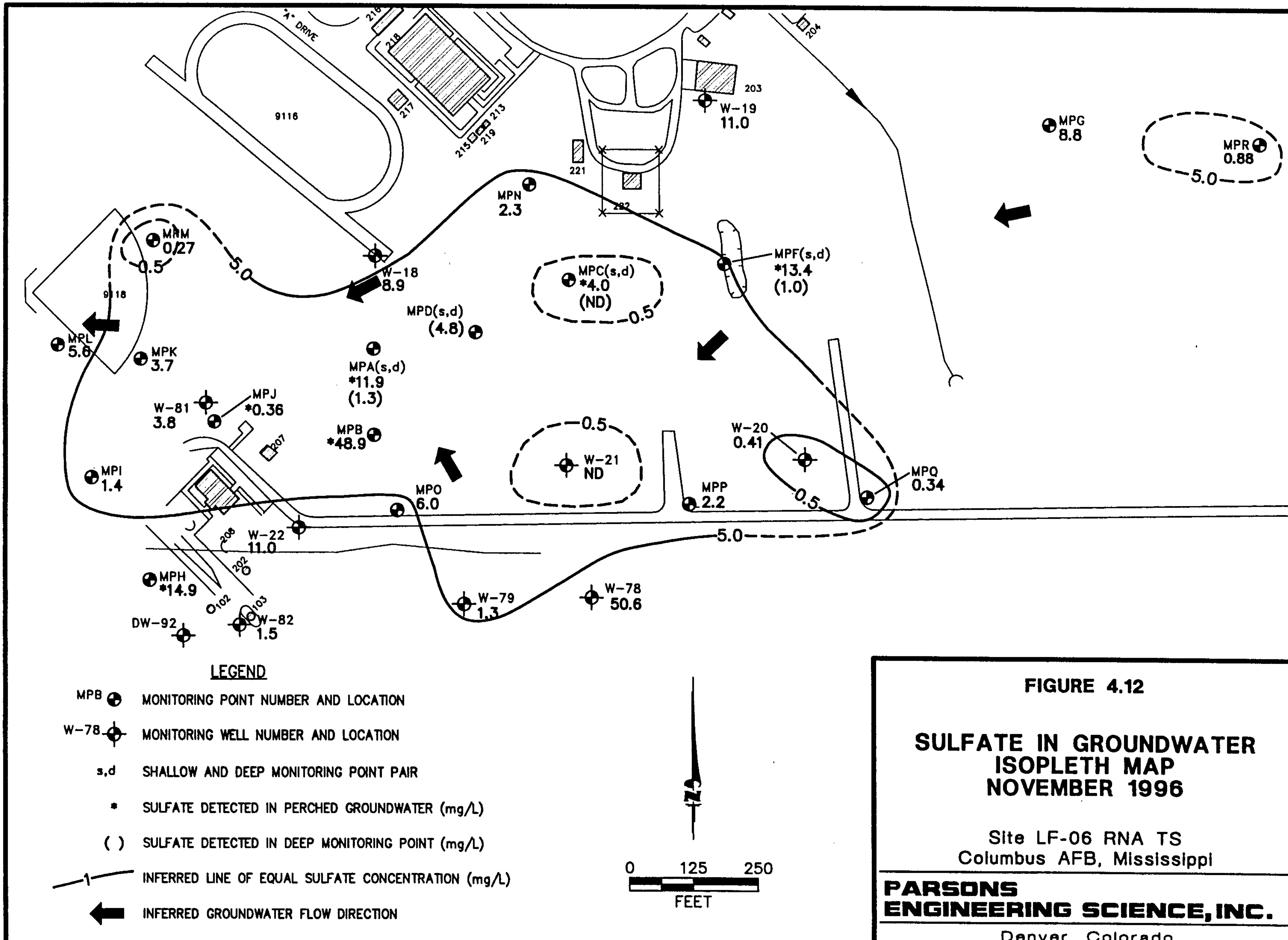

FIGURE 4.12

SULFATE IN GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site LF-06 RNA TS
Columbus AFB, Mississippi

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Denver, Colorado

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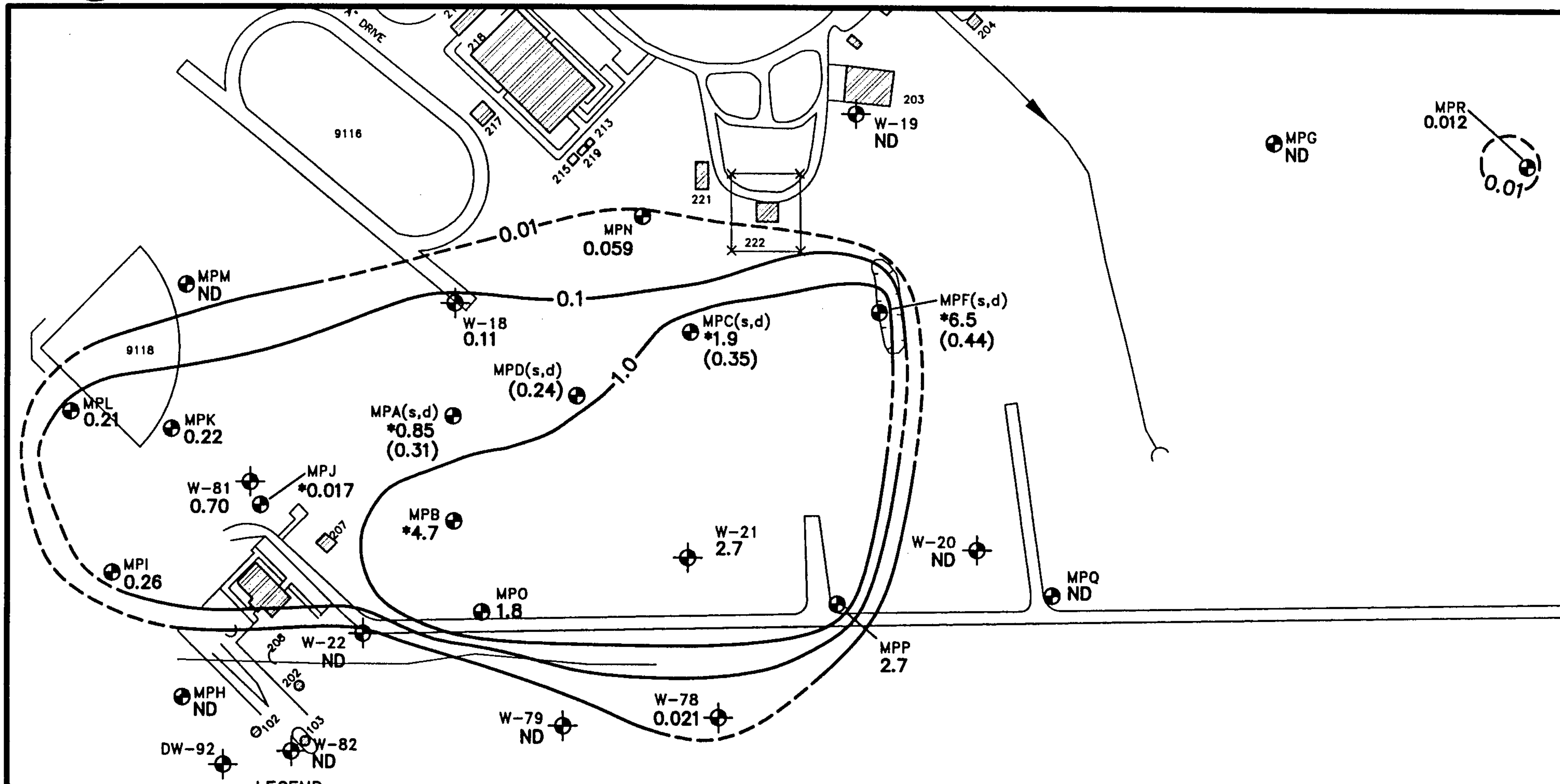

LEGEND

MPB	MONITORING POINT NUMBER AND LOCATION
W-78	MONITORING WELL NUMBER AND LOCATION
s,d	SHALLOW AND DEEP MONITORING POINT PAIR
*	METHANE DETECTED IN PERCHED GROUNDWATER (mg/L)
( )	METHANE DETECTED IN DEEP MONITORING POINT (mg/L)
ND	NOT DETECTED
1.0	LINE OF EQUAL TOTAL BTEX CONCENTRATION (mg/L) (DASHED WHERE INFERRED)
	INFERRED GROUNDWATER FLOW DIRECTION

N

0 125 250
FEET

FIGURE 4.13

METHANE IN GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site LF-06 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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As methanogenesis produces more carbon dioxide than it consumes, an unlimited supply of carbon dioxide is theoretically available once the process of methanogenesis has been initiated. Therefore, methanogenesis is limited by the rate of reaction rather than the source of electron acceptors.

4.4.2 Additional Geochemical Indicators

Other geochemical data collected for this evaluation can be used to further interpret and support the contaminant, electron donor, electron acceptor, and byproduct data previously discussed. These parameters provide additional qualitative indications of what processes may be operating at the site.

4.4.2.1 Oxidation/Reduction Potential

Redox potentials were measured at groundwater monitoring wells and points in November 1996. Redox potential is a measure of the relative tendency of a solution to accept or transfer electrons. The redox potential of a groundwater system depends on which electron acceptors are being reduced by microbes during oxidation of organic compounds. Redox potentials for shallow groundwater at the site range from 284 millivolts (mV) to -300 mV. Table 4.5 summarizes available redox potential data. In some locations, low redox potential coincide with areas of elevated BTEX and solvent concentrations, decreased DO, nitrate, and sulfate concentrations, and elevated ferrous iron and methane concentrations. However, this is not always the case and the correlation between redox potential and geochemical indicators is not strong.

Areas with low redox potentials tend to coincide with areas where there is evidence of ongoing reductive dehalogenation, except in the vicinity of W-21 and MPP. The redox potentials measured at those two locations were 216 mV and 67 mV, respectively. This apparent inconsistency may result from mismeasurement of redox potential due to sampling error or due to the fact that the instrument electrode has varying sensitivities to different redox couples, and thus does not always reflect the complete redox potential for a sample. This pattern may also indicate that concentrations of substrates have always been relatively

low and thus biodegradation reactions have not made significant and lasting changes in groundwater geochemistry in that area. In addition, it is also possible that the November 1996 data reflects that conditions that were formerly reducing changed to more oxidizing due to short-term or long-term changes in site conditions. Such a change may occur due to an influx of more oxidizing water (e.g., from a recharge event) or due to a long-term change in redox conditions due to decreasing substrate concentrations. Finally, the results may also be indicative of heterogeneity, such as a situation in which biodegradation is ongoing in one subunit of the shallow aquifer and the sampling of wells screened over multiple subunits results in mixing of waters from differing redox environments.

4.4.2.2 Alkalinity and Carbon Dioxide Evolution

Carbon dioxide is produced during the biodegradation of petroleum hydrocarbons and native organic carbon compounds. In aquifers that have carbonate minerals as part of the matrix, carbon dioxide forms carbonic acid, which dissolves these minerals, increasing the alkalinity of the groundwater. An increase in alkalinity (measured as $CaCO_3$) in an area with BTEX or chlorinated solvent (particularly less-chlorinated solvents) concentrations elevated above background conditions can be used to infer that petroleum hydrocarbons, less-chlorinated solvents, or native organic carbon has been destroyed through aerobic and anaerobic microbial respiration.

Total alkalinity (as $CaCO_3$) was measured in groundwater samples collected in November 1996. These measurements are summarized in Table 4.5. Alkalinity is a measure of the ability of groundwater to buffer changes in pH caused by the addition of biologically generated acids. Total alkalinity at the site varied from 0 mg/L to 425 mg/L, with the lowest concentrations generally measured in wells/points outside the contaminant plume. However, alkalinity within the plume area is variable, may not always be sufficient to buffer potential changes in pH caused by biologically mediated reactions. The pH data for site groundwater (Section 4.4.2.4) suggest that groundwater pH decreases slightly at some locations within the plume.

Free carbon dioxide concentrations also were measured in groundwater samples collected in November 1996 (Table 4.4). As shown on Figure 4.14, carbon dioxide concentrations within the full extent of the chlorinated solvent and BTEX plumes are elevated noticeably above background concentrations. Background concentrations are about 40 to 100 mg/L, while within the plume area, concentrations are in the range of 100 to 500 mg/L. Carbon dioxide concentrations above background result from both aerobic and anaerobic biodegradation processes as contaminants are ultimately converted to carbon dioxide and water.

4.4.2.3 Ammonia/Ammonium

The presence of ammonia/ammonium in groundwater can result from either nitrate reduction (facilitated by microbes) or fixing of atmospheric nitrogen (also a microbial process). Therefore, the presence of ammonia/ammonium in groundwater is a strong indication of microbial activity. Figure 4.15 shows the distribution of ammonia and ammonium (as N) concentrations measured in groundwater samples collected from LF-06. Ammonia/ammonium concentrations ranged from below detection limits to greater than 10 mg/L (Table 4.4), with the area of highest concentrations coinciding with the central portion of the contaminant plumes (i.e., centered along a line from MPF to MPA to W-81, and between W-18 and MPB).

Given that the highest nitrate concentration observed in site groundwater was 6.7 mg/L and that the highest ammonia/ammonium concentrations are greater than 10 mg/L, the nitrogen component of the ammonia process cannot entirely be derived from nitrate and may come from atmospheric nitrogen gas. This implies that groundwater conditions within the BTEX and solvent plumes are reducing enough to support nitrogen fixation. Stumm and Morgan (1981) note that nitrogen fixation will occur when conditions are at least

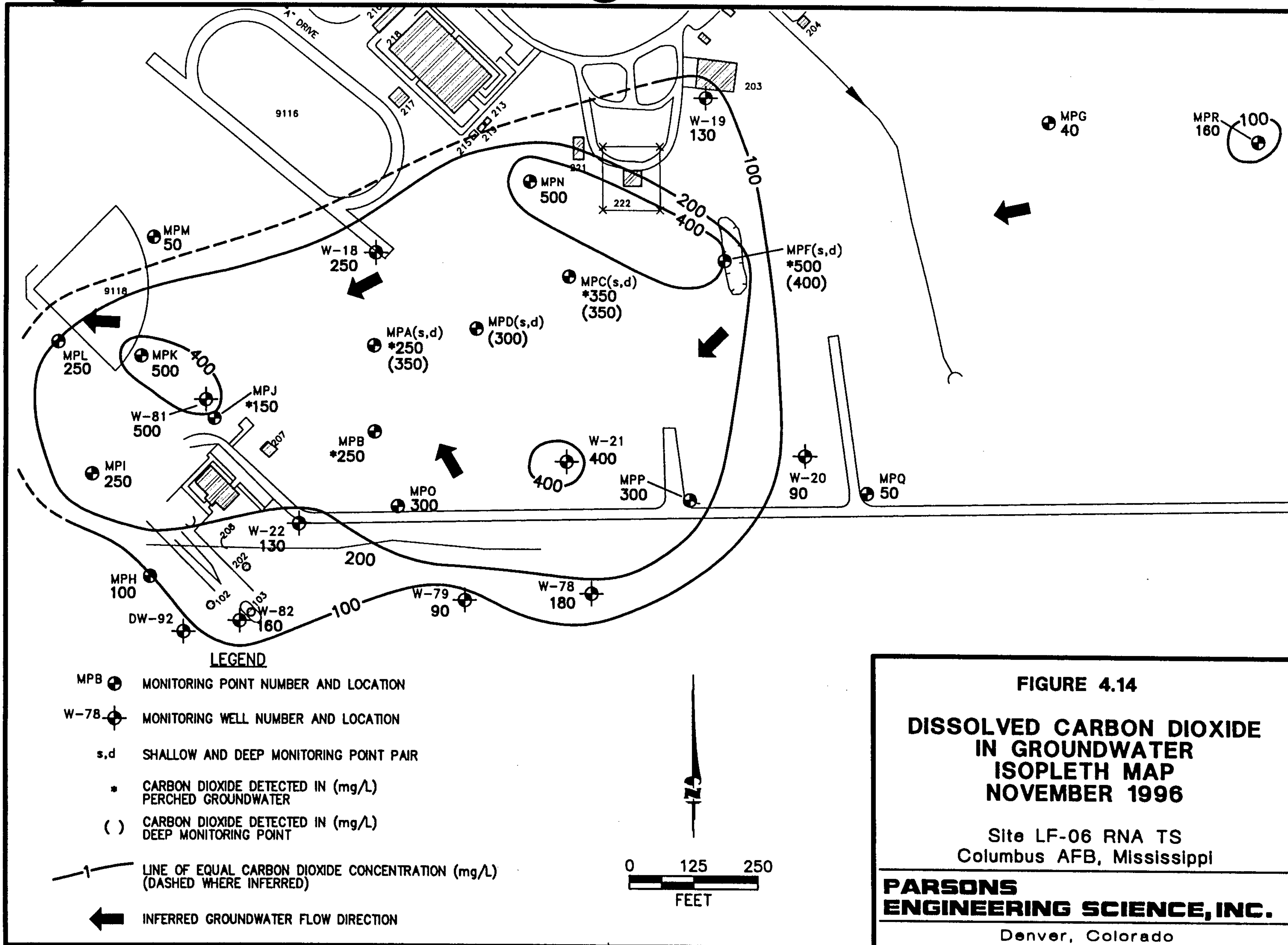

FIGURE 4.14

DISSOLVED CARBON DIOXIDE IN GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site LF-06 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\COLUMBUS\729691\97DN0596, 08/22/97 at 10:14

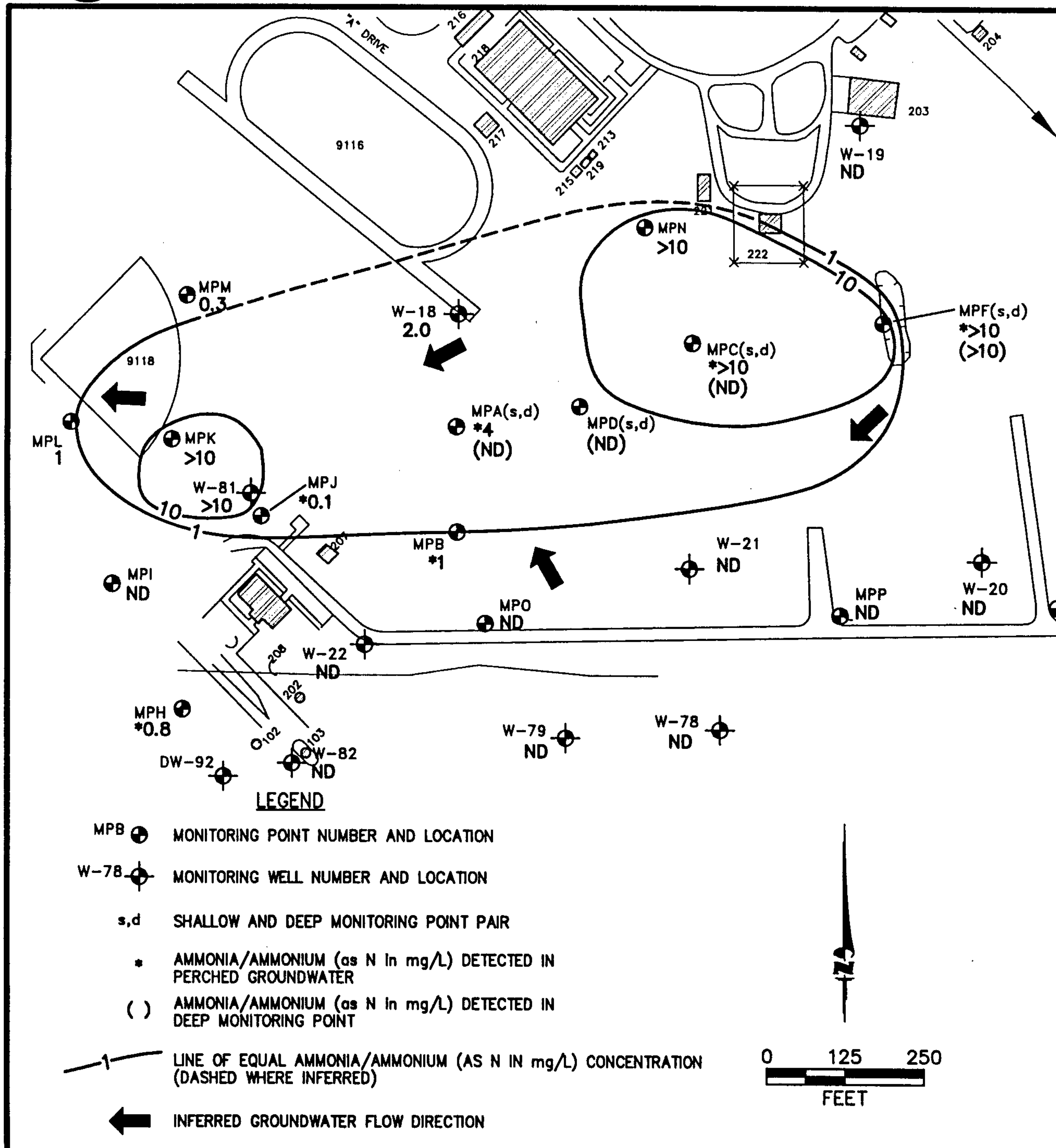

FIGURE 4.15

DISSOLVED AMMONIA/AMMONIUM IN GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site LF-06 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\COLUMBUS\729691\97DN0597, 08/22/97 at 10:23

reducing enough to support iron reduction. This process can also occur when sulfate reduction or methanogenesis is favored. Therefore, this evidence of nitrogen fixation further confirms that conditions within the solvent and BTEX plumes are sufficiently reducing to allow reductive dehalogenation to proceed. This also further confirms that organic matter (anthropogenic or natural) is being biodegraded in the plume area.

It is possible that some nitrate could enter groundwater from the landfill material; however, significant concentrations of nitrate in groundwater generally come from sources such as fertilizer, animal waste, sewage, and septic systems (Freeze and Cherry, 1979; Domenico and Schwartz, 1990). Thus, while it is possible that some nitrate may enter groundwater from material in the disposal trenches, it is more likely that nitrogen fixation is a more significant source of nitrogen for production of ammonia/ammonium.

4.4.2.4 pH

pH was measured for groundwater samples collected from groundwater monitoring points and monitoring wells in November 1996. These measurements are summarized in Table 4.5. The pH of a solution is the negative logarithm of the hydrogen ion concentration [H^+]. Groundwater pH measured at the site ranges from 4.3 to 6.8 standard units. This range of pH is slightly below the optimal range for BTEX-degrading microbes, although microbial activity can occur at a pH as low as 2 (Chapelle, 1993). The slightly acidic range of pHs also indicates that microbial reactions may have a noticeable effect on groundwater pH, likely due to the low background alkalinity of site groundwater (Section 4.4.2.2).

4.4.2.5 Temperature

Groundwater temperature was measured at groundwater monitoring points and monitoring wells in November 1996. Table 4.5 summarizes groundwater temperature readings. Temperature can affects the types and growth rates of bacteria that can be supported in the groundwater environment, with higher temperatures typically resulting in higher growth rates. Groundwater temperatures at LF-06 varied from 16.9°C to 20.8°C.

These are moderately warm temperatures for groundwater (but still within the optimal range), suggesting that bacterial growth rates should be high.

4.5 APPROXIMATION OF BIODEGRADATION RATES

Biodegradation rate constants are necessary to accurately simulate the fate and transport of contaminants dissolved in groundwater. In many cases, biodegradation of contaminants can be approximated using first-order kinetics. First-order biodegradation rate constants may be calculated on the basis of field-scale data, or by using a small sample of the aquifer material and groundwater for microcosm studies.

For reductive dehalogenation of chlorinated compounds, first-order rates are not necessarily an accurate representation because the degradation of CAHs depends on both the concentrations of electron donors (e.g., fuel hydrocarbons or native organic material) and the concentrations of electron acceptors (including inorganic acceptors and CAHs) (Moutoux *et al.*, 1996). Second-order rates would therefore allow more accurate modeling, but at this time there are no readily available groundwater contaminant transport models that can utilize such rates. Therefore, first-order rates must be estimated for such an application.

Microcosm studies are used to show that the microorganisms necessary for biodegradation are present and to help quantify rates of biodegradation. Because microcosm studies are time consuming and expensive, they should be undertaken only at sites where there is considerable skepticism concerning the biodegradation of contaminants. The results of a microcosm study are strongly influenced by the nature of the geological material submitted for study, the physical properties of the microcosm, the sampling strategy, and the duration of the study. Biodegradation rate constants determined by microcosm studies often are much higher than those observed in the field. Microcosms are most appropriate as indicators of the potential for natural bioremediation, and to prove that losses are biological, but it may be inappropriate to use them to generate rate constants.

The preferable method of contaminant biodegradation rate-constant determination is by use of field data.

In order to calculate first-order biodegradation rate constants on the field scale, the apparent degradation rate must be normalized for the effects of dilution, dispersion, and sorption. Two methods for determining first-order rate constants for BTEX compounds are described by Wiedemeier *et al.* (1996b). One method involves the use of a biologically recalcitrant compound found in the dissolved contaminant plume that can be used as a conservative tracer. The other method, proposed by Buscheck and Alcantar (1995), involves interpretation of a steady-state contaminant plume and is based on the one-dimensional, steady-state analytical solution to the advection-dispersion equation presented by Bear (1979). Both methods can be adapted to estimate rate constants for CAHs. Another method for estimating dehalogenation rates of CAHs is described by Moutoux *et al.* (1996). This method provides a total dechlorination rate for all dechlorination steps. All rates (including the rapid TCE to DCE rate and the slow VC to ethene) are averaged together using the Moutoux *et al.* (1996) method.

The method of Buscheck and Alcantar (1995) was used to estimate first-order biodegradation rate constants for BTEX and chlorinated solvents at LF-06. This method and the related calculations are summarized in Section 5.3. The other methods discussed above were not used because the low contaminant concentrations at LF-06 prevented proper analysis. Decay rates computed using data from LF-06 included a total BTEX biodegradation rate of 0.0053 day^{-1}, a chlorobenzene biodegradation rate of 0.010 day^{-1}, and a total chlorinated ethene dechlorination rate of 0.0035 day^{-1}. The equivalent half-lives are 0.35 years, 0.19 years, and 0.54 years, respectively.

4.6 DISCUSSION

Compounds detected in groundwater at LF-06 include BTEX, TCE, *cis*-1,2-DCE, 1,1-DCE, VC, 1,1,1-TCA, 1,1-DCA, CA, 1,3-DCB, 1,4-DCB, and CB. Of these compounds, only benzene, CB, TCE, and VC were detected at concentrations exceeding

MCLs. At only one location was a benzene concentration exceeding the MCL of 5 µg/L detected. At MPF(s), the benzene concentration was 12 µg/L. MPF(s) is screened in a perched zone, and the benzene concentration in the point below it [MPF(d), actually screened in the (continuous) shallow aquifer], the benzene concentration was only 2.1 µg/L.

CB was detected at a concentration of 200 µg/L in MPF(s), exceeding the MCL of 100 µg/L. In the sample from MPF(d), the CB concentration was only 6.1 µg/L. Also, no other CB concentration was greater than 23 µg/L (at MPN). TCE was detected in only 3 samples, and in only one (from W21) did the concentration (7.4 µg/L) exceed the MCL of 5 µg/L. VC was the most commonly detected compound exceeding standards, with concentrations exceeding the MCL of 2 µg/L detected in samples from 14 wells and monitoring points. However, none of these concentrations were greater than 10 µg/L.

Data have been collected from several wells at the site since 1988, and changes in concentrations of compounds present in concentrations exceeding MCLs over that time are shown in Table 4.6. Some concentrations have decreased slightly, but contaminant concentrations in single monitoring wells generally have fluctuated over time, with no clear overall trends of increasing or decreasing concentrations (i.e., some increase, some decrease, and some are relatively constant). This is likely a function of the low concentrations, mixing in wells during sampling, slight differences in sampling procedures, variations in plume concentrations due to water level/flow direction changes, and variable rates of desorption from aquifer solids.

TABLE 4.6
CONCENTRATION HISTORIES FOR COMPOUNDS DETECTED IN GROUNDWATER IN CONCENTRATIONS EXCEEDING MCLs
SITE LF-06 RNA TS
COLUMBUS AFB, MISSISSIPPI

Contaminant		Contaminant Concentration (μg/L)								
(MCL)	Well	Mar-88	Apr-88	Jul-88	Dec-88	May-89	Nov-91	Nov-94	Aug/Sep 95	Nov-96
TCE	W-21	NA[a]	ND[b]	ND	ND	ND	4J[c]	26	26	7.4
(5 μg/L)	W-22	NA	ND	ND	ND	ND	14	ND	ND	ND
VC	W-18	NA	15	ND	NA	15	6J	8	ND	4.9
(2 μg/L)	W-20	NA	ND	ND	ND	9.8	NA	0.4J	ND	ND
	W-21	NA	26	ND	21	22	10	33	16	10
	W-81	NA	NA	NA	NA	NA	NA	6	ND	4.8
CB	W-18	NA	19	21	NA	21	ND	24	25	13
(100 μg/L)	W-20	NA	ND	ND	7	4.8	NA	ND	ND	ND
	W-21	NA	12	5	9	17	6	10	19	13
	W-81	NA	NA	NA	NA	NA	NA	12	13	6.5
	MPF(s)[d]	NS[e]	NS	NS	NS	NS	NS	NS	NS	200
Benzene	W-18	NA	ND	ND	NA	ND	2J	2	ND	1.3
(5 μg/L)	W-21	NA	ND	ND	ND	ND	2J	3	ND	3.6
	W-22	NA	ND	ND	ND	ND	20	ND	ND	ND
	W-81	NA	NA	NA	NA	NA	NA	2	ND	0.9
	MPF(s)[d]	NS	NS	NS	NS	NS	NS	NS	NS	12
	W3[d]	NS	NS	NS	NS	NS	NS	NS	NS	15

[a] NA = not analyzed.
[b] ND = not detected.
[c] J = estimated concentration.
[d] Only location(s) where compound detected above MCL (in 1996).
[e] NS = not sampled.

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In the case of CB, the one concentration exceeding the MCL was not detected until 1996, and then it was detected in MPF(s), which is screened in a perched zone. In the case of benzene, only one concentration exceeding the MCL was detected in new monitoring points [specifically, MPF(s)] in 1996. Previously, only one sample at another location (W-22 in November 1991) had contained benzene at a concentration exceeding the MCL. At that time, the benzene concentration was 20 µg/L, and was the only instance in which benzene was detected in that well. Of the other compounds detected in 1996 at concentrations that do not exceed standards (32 total detections), no single concentration exceeds 20 µg/L, and all but three of the 32 detected concentrations are under 10 µg/L.

The additional data collected for this effort also help to suggest three possible locations for sources of groundwater contamination in the LF-06 area. These locations include the apparent former trench in the vicinity of MPF, the area between MPP and W-21, and an area upgradient of MPN. The nature of these sources of fuel hydrocarbons and chlorinated solvents is not clear; however, the low dissolved concentrations do suggest that no mobile NAPL is present, and that the mass of each compound released to groundwater is not significant. The lack of information on the sources remains a problem because contaminant mass loading cannot be evaluated and the possibility of new releases cannot be discounted. However, the low concentrations of dissolved contaminants implies that existing sources are minor and that any future releases are likely to produce similar (low) concentrations.

Several lines of chemical and geochemical evidence indicate that the contaminants at LF-06 are being biodegraded, either as substrates or as electron acceptors. Geochemical data indicate that DO, nitrate, and sulfate are being consumed and iron (II) and methane are produced within that same area as the plume. This evidence suggests that microbial consumption of anthropogenic and natural organic matter (carbon compounds) is taking place at LF-06. Anthropogenic carbon compounds are present as petroleum hydrocarbons and less-chlorinated solvents (including, but not limited to, BTEX, chlorobenzene, VC,

DCE, and DCA) that are dissolved in groundwater, and probably as landfill leachate. Native carbon compounds include solid organic matter in the aquifer matrix and whatever portion of that matter that has dissolved into site groundwater. These compounds are electron donors in redox reactions that are also consuming electron acceptors (e.g., DO, ferric iron, carbon dioxide, and chlorinated hydrocarbons) and creating byproducts [e.g., methane, iron (II), and carbon dioxide]. Plots of contaminants, electron donors, electron acceptors, and byproducts of biodegradation reactions (Figures 4.3 through 4.15) provide strong qualitative evidence of these processes. Plots of additional indicators, such as carbon dioxide and ammonia concentrations, further indicate that biodegradation reactions are ongoing.

Microbial consumption of both native and anthropogenic organic carbon compounds destroys those compounds and creates conditions favorable for reductive dehalogenation. Site chemical data provide evidence of dehalogenation of TCE, DCE, TCA, and DCA. The presence of *cis*-1,2-DCE and VC in site groundwater coupled with evidence of sufficiently reducing conditions provides the primary line of chemical evidence for reductive dehalogenation of chlorinated ethenes. The presence of 1,1-DCA and CA also suggest that 1,1,1-TCA is being reductively dehalogenated in the central portion of the contaminant plume. The presence of dissolved methane further indicates that conditions are sufficiently reducing for the dehalogenation processes to proceed.

Elevated chloride concentrations within the solvent plumes also may indicate dehalogenation reactions, although chloride may also come from some of the wastes in the landfill and from oxidation of less-chlorinated compounds (i.e., utilization as a substrate). However, because of the other evidence of reductive dehalogenation, it is highly likely that some fraction of the excess chloride is a result of chlorinated solvent degradation. In addition, the fact that *cis*-1,2-DCE is detected instead of *trans*-1,2-DCE in wells/points where TCE or VC also are present is also indicative of biologically mediated reductive dehalogenation.

Evidence also suggests that 1,1,1-TCA is being abiotically dehydrohalogenated to 1,1-DCE at the margins of the contaminant plume. On the other hand, the absence of 1,1,1-TCA and the presence of 1,1-DCA and CA in wells that also contained BTEX and chlorinated ethenes suggests that reductive dechlorination of TCA is ongoing within the central area of the contaminant plume. It therefore appears that 1,1,1-TCA is reductively dehalogenated in the central plume area, while in the periphery wells (where conditions are less reducing), TCA is not reductively dechlorinated but instead reacts abiotically to form 1,1-DCE.

Given the available evidence, the dissolved CAH plume at LF-06 exhibits characteristics of both type 1 and type 3 behavior. Dissolved petroleum hydrocarbons and possibly some less-chlorinated solvents appear to act as carbon sources. It is likely that the introduction of petroleum hydrocarbons and solvents due to waste disposal activities stimulated additional microbial activity and made the groundwater system reducing enough to allow reductive dehalogenation of TCE, DCE, and TCA. VC has been created due to dehalogenation, but it is possible that it is being oxidized (as a substrate) once it enters aerobic groundwater. Likewise, it is possible that DCE and DCA are oxidized as well. However, conclusive evidence of these oxidation processes has not been gathered. It is possible that some microbial consumption of native organic matter is taking place outside the plume and within the plume, but the DO values measured outside of the contaminant plume suggest this process is minor. Type 2 behavior may therefore be limited in extent and is not discernible from consumption of contaminants.

As discussed in Section 4.5, rates of BTEX, chlorobenzene, and chlorinated ethene degradation estimated from data collected for this investigation were 0.010 day^{-1}, 0.018 day^{-1}, and 0.006 day^{-1}, respectively As petroleum hydrocarbons and native organic matter continue to be consumed, reductive dehalogenation of the chlorinated ethenes will continue; however, once BTEX compounds are completely degraded, the rate at which dehalogenation proceeds may slow as the microbes utilize less easily degradable fuel

hydrocarbons or other organic matter. It also is conceivable that the plume may eventually come to display only type 3 behavior, but this will depend on the concentrations and degradability of the remaining (non-BTEX) fuel hydrocarbon compounds relative to the native organic matter.

As the type of organic matter used during biodegradation changes, the redox conditions also may change and alter which reactions are favored. This could also affect the rates at which CAHs are reductively dehalogenated, and could also cause dehalogenation of some compounds to cease. If and how this will happen is difficult to predict; the relative "degradability" of the native organic matter (or non-BTEX fuel hydrocarbons) and the effect of a changing electron donor source is not yet well-understood. It can be stated that if conditions become more oxidizing (but not aerobic), the dehalogenation of DCE may also cease or slow. However, aerobic and/or anaerobic mineralization of VC and DCE may become more important (i.e., type 3 conditions may dominate).

SECTION 5

GROUNDWATER MODELING

5.1 GENERAL OVERVIEW

To help estimate degradation rates for dissolved BTEX compounds and chlorinated solvents at LF-06 and to help predict the future migration of these compounds, Parsons ES modeled the fate and transport of the compounds that exceeded Mississippi Department of Environmental Quality (MDEQ) groundwater quality standards. The modeling effort has three primary objectives: (1) to predict the future extent and concentration of the dissolved contaminant plume by modeling the combined effects of advection, dispersion, sorption, and biodegradation; (2) to assess the potential for exposure of downgradient receptors to contaminant concentrations that exceed regulatory standards intended to be protective of human health and the environment; and (3) to provide technical support for the natural attenuation option at post-modeling regulatory negotiations, as appropriate. The model was developed using site-specific data and conservative assumptions about governing physical and chemical processes. Because of the conservative nature of model input, the reduction in contaminant mass caused by natural attenuation may exceed model predictions. This analysis is not intended to represent a baseline assessment of potential risks posed by site contamination.

Partial differential equations that describe groundwater flow and/or solute transport can be solved analytically or numerically. The type of model selected to simulate site conditions depends on the complexity of the problem, the amount of available data, the importance of the decisions that will be based upon the model, and project scope. Analytical methods (models) provide exact, closed-form solutions, and numerical methods

(models) provide approximate solutions. Analytical models are the simplest to set up and solve, allowing the user to evaluate many scenarios in a relatively short time. Numerical methods are more efficient for those systems that are too complex for analytical methods. Analytical models are restricted in the nature of the problems for which they can be used, and for some transport problems they may become so complex and unwieldy that the use of numerical methods may be more efficient. Theoretically, there are no limits on the characteristics of the hydrogeological system and the properties of the solute(s) that can be simulated using a numerical model code. There are, however, practical limits on the ways in which the system and any reactions within it can be represented. The basic parameters for both types of models typically include groundwater seepage velocity, hydraulic conductivity, saturated thickness of the aquifer, porosity, source area configuration, source area contaminant concentrations, leakage rates, dispersion coefficients, retardation values, and decay rates.

If limited data are available, or the hydrogeologic conditions are simple, an analytical model can be selected to simulate contaminant fate and transport. Analytical solutions provide exact, closed-form solutions to the governing advection-dispersion equation by making significant simplifying assumptions. Analytical solutions are most accurate where these assumptions closely approximate the actual system. Because of the nature of the simplifying assumptions, analytical models may overestimate or underestimate the spread of contamination. By making assumptions that will ensure the model will overpredict contaminant concentrations and travel distances (or at least not underpredict them), the model predictions will be conservative. The more conservative a model is, the more confidence there should be that potential receptors will not be impacted by site contamination. Analytical solutions are generally limited to steady, uniform flow or radial flow, and should not be used for groundwater flow or solute transport problems in strongly anisotropic or heterogeneous media.

Numerical solutions provide approximate solutions to the advection-dispersion equation. Numerical models are less burdened by simplifying assumptions and are capable of addressing more complicated problems. Unlike analytical models, numerical models allow subsurface heterogenieties and varying aquifer parameters to be simulated, as well as transient simulations (i.e., one or more properties or conditions change over time), if the requisite data are available. Many of the assumptions required for the analytical solutions are not necessary when numerical techniques are used to solve the governing solute transport equation. However, a greater amount of site-specific data is needed to implement a numerical model, and the solutions are inexact numerical approximations. The added complexity of performing a numerical model typically is not warranted unless the spatial distribution of input parameters is well documented.

Analytical models were selected to evaluate contaminant fate and transport at LF-06. Analytical models are appropriate at this site because the spacial variability regarding hydrogeologic conditions, geochemical measurements, and contaminant concentration information is limited. The models used with LF-06 data provided first-order solute decay solutions for a semi-infinite system with a constant point source (van Genuchten and Alves, 1982). The models assume a homogeneous, isotropic aquifer; a uniform, constant-velocity flow field in the x-direction only; a constant longitudinal hydrodynamic dispersion; a first-order rate of decay for biodegradation; and a linear sorption rate.

5.2 CONCEPTUAL MODEL DESIGN AND ASSUMPTIONS

Before developing a groundwater model, it is important to develop a reasonable interpretation of aquifer conditions. On the basis of the data presented in Section 3, the shallow saturated zone was conceptualized and modeled as a shallow unconfined aquifer composed of fine to medium sand with some gravel (Figure 3.3). Water level data suggest a relatively uniform local groundwater flow system without a significant vertical component.

Geochemical data presented in Section 4 suggest that biodegradation of site contaminants is occurring. In particular, BTEX and chlorinated solvent compounds are being degraded by aerobic respiration and the anaerobic processes of denitrification, ferric iron reduction, manganese reduction, sulfate reduction, nitrogen fixation, and methanogenesis. In addition, the processes of reductive dehalogenation and dehydrohalogenation are currently reducing the dissolved chlorinated solvent mass. Current analytical data on dissolved BTEX and chlorinated solvent concentrations were used for model calibration and to support solute reduction assumptions; historical information was limited to the landfill periphery, and therefore, was of limited use for hot spot identification, plume definition, and model calibration.

5.3 INITIAL MODEL SETUP

Where possible, the initial setup for the models was based on site data. Where site-specific data were not available (e.g., for effective porosity), reasonable assumptions were made on the basis of widely accepted literature values. The analytical model solution is based on calculations for retarded flow with biodegradation and a decaying source (van Genuchten and Alves, 1982). However, because of the lack of historical site data and information, it was assumed that the source(s) present at LF-06 would remain constant over time (i.e., no decay). The following sections describe the basic model setup. The analytical model parameters that were varied during model runs are discussed in Section 5.6.

5.3.1 Groundwater Gradient

The November 1996 water table elevation map presented on Figure 3.5 was used to determine the hydraulic gradient. Groundwater flow in the vicinity of the site is to the west with an average gradient of approximately 0.006 ft/ft. Due to the lack of consistent historical groundwater elevation data, it was assumed that the November 1996 water levels and gradient are representative of steady-state conditions.

5.3.2 Dissolved Contaminant Concentrations

Models were constructed for compounds with dissolved concentrations exceeding MDEQ regulatory limits, including benzene, CB, TCE, and VC. Tables 4.2 and 4.3 present November 1996 dissolved BTEX and chlorinated solvent concentration data. Figures 4.3 through 4.7 show the areal distribution of selected dissolved contaminants in November 1996. The shape and distribution of the contaminant plumes are the result of advective-dispersive transport and biodegradation of dissolved contamination originating from the source areas at LF-06. The highest dissolved concentrations from the November 1996 site investigation were used in the models to project future downgradient concentrations.

5.3.3 Degradation Rates

Available data strongly suggest that aerobic and anaerobic degradation processes are occurring at the site. As with a large number of biological processes, biodegradation can generally be described using a first-order rate constant and the equation:

$$\frac{C}{C_0} = e^{-kt}$$

where: C = Contaminant Concentration at Time t
C_0 = Initial Contaminant Concentration
k = Coefficient of Decay (decay rate constant)
t = time

Two methods of calculating rate constants are currently available to quantify rates of biodegradation at the field scale. The first method involves the use of a biologically recalcitrant compound as a conservative tracer. The second method, proposed by Buscheck and Alcantar (1995), involves interpretation of a steady-state contaminant plume configuration and is based on the one-dimensional steady-state analytical solution to the advection-dispersion equation presented by Bear (1979). An acceptable tracer could not be found for any of the individual chlorinated and nonchlorinated compounds in groundwater;

therefore, only the Buscheck and Alcantar method for estimating biodegradation rates was used to calculate site and chemical specific decay rates.

Buscheck and Alcantar (1995) derive a relationship that allows calculation of first-order decay rate constants for steady-state plumes. This method involves coupling the regression of contaminant concentration (plotted on a logarithmic scale) versus distance downgradient (plotted on a linear scale) to an analytical solution for one-dimensional, steady-state, contaminant transport that includes advection, dispersion, sorption, and biodegradation. For a steady-state plume, the first-order decay rate is given by (Buscheck and Alcantar, 1995):

$$\lambda = \frac{v_c}{4\alpha_x}\left(\left[1 + 2\alpha_x\left(\frac{k}{v_x}\right)\right]^2 - 1\right)$$

where: λ = first-order decay rate
v_c = retarded contaminant velocity in the x-direction
α_x = dispersivity
k/v_x = slope of line determined from a log-linear plot of contaminant concentration versus distance downgradient along flow path

The first-order decay rate includes biodegradation resulting from both aerobic and anaerobic processes; however, in the absence of oxygen, the first-order rate is equivalent to the anaerobic decay rate. Table 5.1 presents the data for a first-order rate constant calculation for BTEX using November 1996 data at LF-06 and the method proposed by Buscheck and Alcantar (1995). An exponential fit to the data estimates a log-linear slope of 0.0021. This value translates to a decay constant of 0.0053 day^{-1} which was used in the BTEX and benzene models. Calculated decay constants for chlorobenzene (Table 5.2) and chlorinated ethenes (Table 5.3) were 0.010 day^{-1} and 0.0035 day^{-1}, respectively. These rates were used in the analytical fate and transport models for chlorobenzene (0.010 day^{-1}) and TCE and VC (0.0035 day^{-1}).

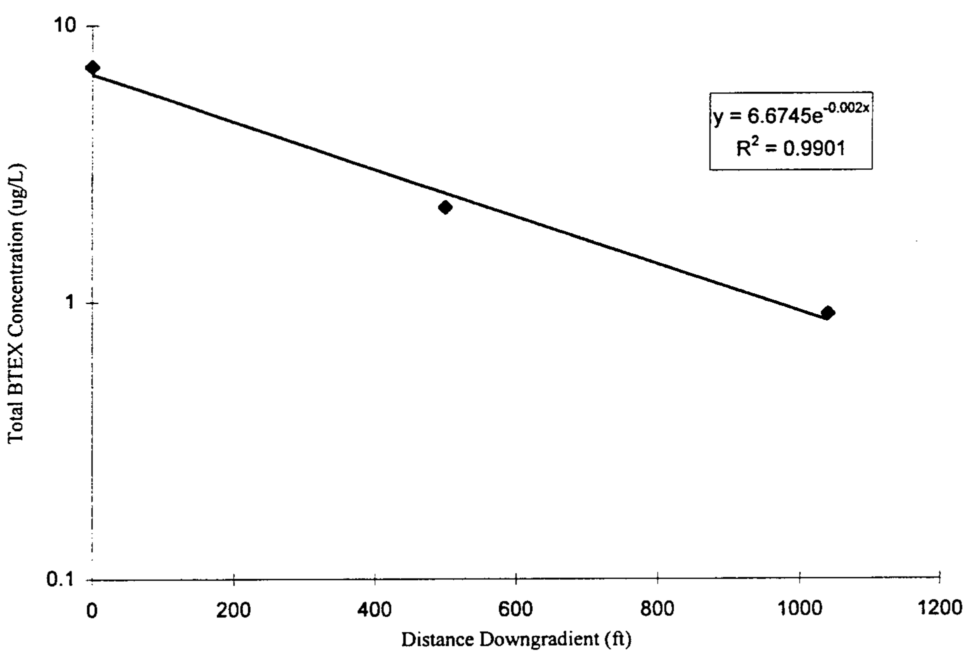
A review of recent literature indicates that similar or higher rate constants generally have been observed in anaerobic plumes at other sites. For example, Chapelle (1994)

TABLE 5.1
FIRST-ORDER RATE CONSTANT CALCULATION
USING THE METHOD OF BUSCHECK AND ALCANTAR (1995)
LF-06

REMEDIATION BY NATURAL ATTENUATION TS
COLUMBUS AFB, MISSISSIPPI

Point	Distance Downgradient from Source (ft)	Total BTEX (μg/L) Oct-96
MPF	0	7.1
MPD	500	2.2
W-81	1040	0.9

PLOT OF TOTAL BTEX CONCENTRATION VERSUS DISTANCE



$$\lambda = v_c/4\alpha_x([1+2\alpha_x(k/v_x)]^2-1)$$

where	$v_c =$	2.2000	ft/day
	$\alpha_x =$	100	ft
	$k/v =$	0.002	ft-1
therefore	$\lambda =$	0.0053	day-1

TABLE 5.2
FIRST-ORDER RATE CONSTANT CALCULATION
USING THE METHOD OF BUSCHECK AND ALCANTAR (1995)

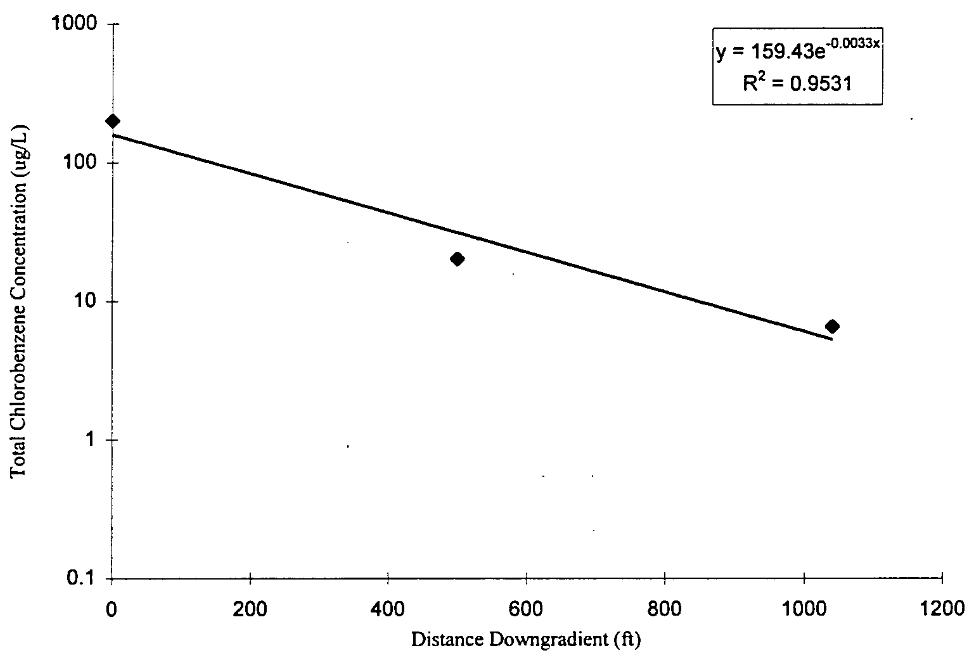
LF-06

REMEDIATION BY NATURAL ATTENUATION TS

COLUMBUS AFB, MISSISSIPPI

Point	Distance Downgradient from Source (ft)	Chlorobenzene (μg/L) Oct-96
MPF	0	200
MPA	500	20
W-81	1040	6.5

PLOT OF TOTAL CHLOROBENZENE CONCENTRATION VERSUS DISTANCE



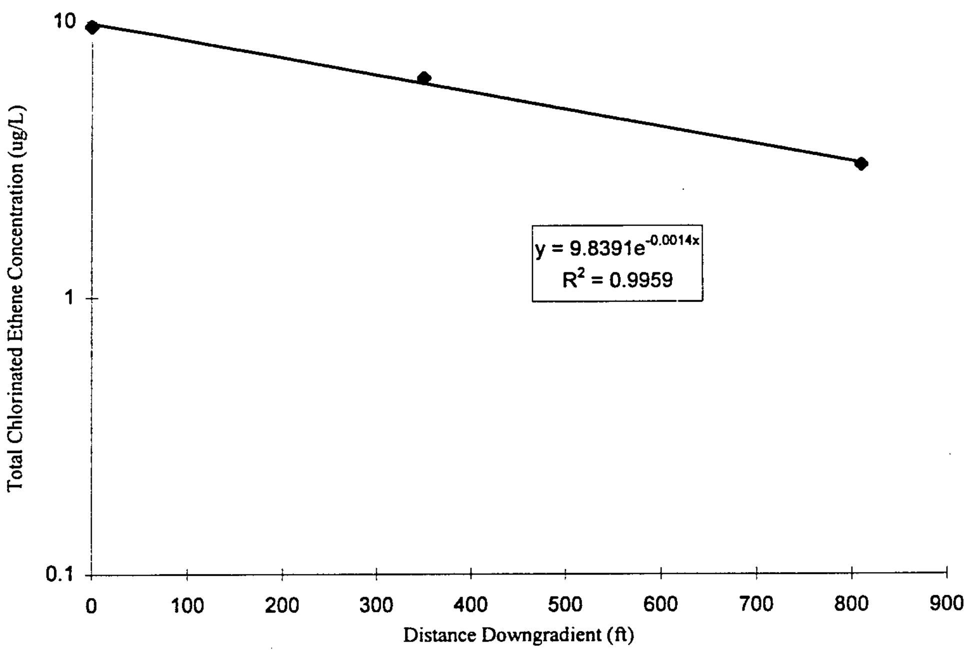
$$\lambda = v_c/4\alpha_x([1+2\alpha_x(k/v_x)]^2-1)$$

where	v_c =	2.2000	ft/day
	α_x =	100	ft
	k/v =	0.0033	ft-1
therefore	λ =	0.010	day-1

TABLE 5.3
FIRST-ORDER RATE CONSTANT CALCULATION
USING THE METHOD OF BUSCHECK AND ALCANTAR (1995)
LF-06
REMEDIATION BY NATURAL ATTENUATION TS
COLUMBUS AFB, MISSISSIPPI

Point	Distance Downgradient from Source (ft)	Total Chlorinated Ethenes (μg/L) Oct-96
MPN	0	9.6
W-18	350	6.2
MPK	810	3

PLOT OF TOTAL CHLORINATED ETHENE CONCENTRATION VERSUS DISTANCE



$$\lambda = v_c/4\alpha_x([1+2\alpha_x(k/v_x)]^2-1)$$

where	v_c =	2.2000	ft/day
	α_x =	100	ft
	k/v =	0.0014	ft-1
therefore	λ =	0.0035	day-1

reported that at two different sites with anaerobic groundwater conditions the rate constants were both approximately 0.01 day^{-1}. Wilson *et al.* (1994) report first-order anaerobic biodegradation rates of 0.05 to 1.3 $week^{-1}$ (0.007 to 0.185 day^{-1}); Buscheck *et al.* (1993) report first-order attenuation rates in a range of 0.001 to 0.01 day^{-1}; and Stauffer *et al.* (1994) report rate constants of 0.01 and 0.017 day^{-1} for benzene and *p*-xylene, respectively.

5.4 MODEL CALIBRATION

True model calibration was not performed due to the lack of source area and site information. However, using known site specific hydrogeological information, a site specific biodegradation rate for BTEX compounds, and a source concentration equal to the highest observed concentration, it was shown (Model-BTEX) that the current extent of the dissolved BTEX plume was accurately simulated at steady-state conditions. Furthermore, Model-BTEX predicted that the dissolved BTEX plume would reach steady state in just over 1 year with constant input terms. Knowing that Model-BTEX accurately predicted the extent of dissolved BTEX contamination, the remaining predictive models were also run using the same hydrogeologic parameters: a hydraulic gradient of 0.0055 ft/ft, hydraulic conductivity of 99 ft/day, effective porosity of 0.25, and TOC of 0.06 percent.

To model contaminant distribution for the contaminants of concern (benzene, CB, TCE, VC), it was also assumed that no annual source decay occurred. Assuming no annual source decay may not be an accurate representation of site conditions because it does not account for natural degradation of the source as well as dissolution of the source into groundwater; however, the assumption makes predictive models potentially conservative. The compound specific solute decay rates also were used in predictive models (Section 5.3.3). The highest observed concentrations of the compounds of concern were used as the source input terms for each respective model.

5.5 MODEL RESULTS

Four models were run to predict how far downgradient dissolved concentrations of contaminant of concern (benzene, TCE, CB, VC) exceeded state groundwater criteria (Section 6). Because source decay was not incorporated into the predictive models, time to remediation is not evaluated in this TS. However, assuming that contaminant concentrations exceeding state groundwater standards would persist throughout time (lack of historical site information makes this assumption valid), estimates of contaminant plume length were predicted. Model input and output are presented in Appendix C.

Model-BZ presents the predicted lateral extent of dissolved benzene concentrations at steady state conditions (approximately mid 1998). Using the November 1996 highest observed benzene concentration of 15 μg/L (monitoring point MPF), Model-BZ predicted that dissolved benzene concentrations would exceed the 5 μg/L state groundwater standard for approximately 360 feet west of (downgradient from) monitoring point MPF. At point MPC, the closest downgradient from MPF, the observed benzene concentration was less than 2 μg/L. The fact that this point is approximately 300 feet downgradient suggests that the model is conservative.

Model-CB presents the predicted lateral extent of dissolved chlorobenzene concentrations at steady state conditions. Assuming a source area concentration of dissolved chlorobenzene of 200 μg/L (observed at monitoring point MPF in November 1996), Model-CB predicts that CB concentrations will exceed the state groundwater standard of 100 μg/L for approximately 100 feet downgradient from the point source MPF. This model slightly underpredicts observed downgradient concentrations; however, a concentration of CB in a perched groundwater zone at MPC suggests that observed concentrations may have been boosted by a minor secondary source.

Model-TCE presents the predicted lateral extent of dissolved TCE concentrations at steady state conditions. Assuming a source area concentration of dissolved TCE of 7.5 μg/L (observed at W21 in November 1996), Model-TCE predicts that TCE concentrations

will exceed the state groundwater standard of 5 μg/L for approximately 165 feet downgradient from the point source W21. This rate of decrease is slightly conservative.

Model-VC presents the predicted lateral extent of dissolved VC concentrations at steady state conditions. Assuming a source area concentration for dissolved VC of 10 μg/L (observed at W21 in November 1996), Model-VC predicts that VC concentrations will exceed the state groundwater standard of 2 μg/L for approximately 1,000 feet downgradient from the point source W21. The observed VC plume actually migrates approximately 500 feet downgradient from W21. The plume that originates at MPF stretches for approximately 1,500 feet; however, several minor sources may be contributing to the plume extent. Furthermore, this VC plume extends only about 500 feet downgradient from the edge of the landfill.

5.6 SENSITIVITY ANALYSIS

The purpose of the sensitivity analysis is to determine the effect of varying model input parameters on model output. The sensitivity analysis for model input parameters was conducted on Model-BTEX by varying hydraulic conductivity (±2 times), the organic carbon content (±2 times), effective porosity (±25%), dispersivity (±2 times), and the solute decay rate (±2 times). To perform the sensitivity analyses, the model was run with the same input as the original predictive model excepting the tested parameter. The models were run for a 2-year period so the effects could be compared to steady state conditions simulated by the predictive models, also using a 2-year period. Model output data from the sensitivity analysis are presented in Appendix C.

The results of the sensitivity analysis suggest that the models are most sensitive to hydraulic conductivity, total organic carbon, and solute decay, and less sensitive to effective porosity and dispersivity. Increasing hydraulic conductivity significantly increased the distance of plume migration and the downgradient concentrations of dissolved contaminants, because advective-dispersion mechanisms are more significant with the higher groundwater velocity that results from a higher hydraulic conductivity. Conversely,

decreasing the hydraulic conductivity to half the observed value decreases the distance of plume migration to less than the distance observed in November 1996. Increasing the total organic carbon content decreases the distance of plume migration to less than the distance observed in November 1996. A decrease in the organic carbon content had the opposite effects on the modeled BTEX plume. Changes to the modeled dissolved BTEX plume arising from varying the effective porosity are similar to the changes observed with varying TOC; however, over the evaluated ranges, effective porosity had a smaller effect on the predicted plume than TOC. Changes in the dispersivity value had a similar, but less pronounced, effect on the predicted contaminant plume as did changes to the hydraulic conductivity. Increasing the solute decay rate by two caused the model to produce a contaminant plume of lesser extent than observed in November 1996. Decreasing the solute decay rate made the predicted 1996 plume more than two times as large as the plume observed in November 1996.

The results of the sensitivity analysis indicate that the calibrated model is generally reasonable. Varying the model parameters within the prescribed ranges generally caused the extent and magnitude of the dissolved BTEX plume to differ noticeably from measured conditions.

SECTION 6

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

This section presents the development and comparative analysis of groundwater remedial alternatives for contaminated groundwater at Site LF-06. The intent of this evaluation is to determine if RNA of groundwater is an appropriate and cost-effective remedial approach to consider when developing final remedial strategies for the study area, especially when combined with other remedial technologies.

Section 6.1 presents the criteria used to evaluate groundwater remedial alternatives. Section 6.2 discusses the development of remedial alternatives considered as part of this demonstration project. Section 6.3 provides a brief description of each of these remedial alternatives. Section 6.4 provides a more detailed analysis of the remedial alternatives using the defined remedial alternative evaluation criteria. The results of this evaluation process are summarized in Section 6.5.

6.1 REMEDIAL ALTERNATIVE EVALUATION CRITERIA

The evaluation criteria used to identify appropriate remedial alternatives for shallow groundwater contamination at the site were evaluated on the basis of (1) long-term effectiveness and permanence, (2) technical and administrative implementability, and (3) relative cost. The following sections briefly describe the scope and purpose of each evaluation criterion. This report focuses on the potential use of RNA to reduce dissolved BTEX and chlorinated solvent concentrations in the shallow groundwater below MCLs. Source reduction is not considered because the sources at LF-06 have not been identified and are likely scattered throughout the burial area.

6.1.1 Long-Term Effectiveness and Permanence

Each remedial alternative (which can be a combination of remedial approaches such as RNA and institutional controls) was analyzed to determine how effectively it will minimize groundwater plume expansion so that groundwater and surface water quality standards can be achieved at a downgradient sentry well. The expected technical effectiveness based on case histories from other sites with similar conditions also is evaluated. The ability to minimize potential impacts on surrounding facilities and operations is considered. Also, the ability of each remedial alternative to protect both current and potential future receptors from potential risks associated with potentially completed exposure pathways is qualitatively assessed. This evaluation criterion also included permanence and the ability to reduce contaminant mass, toxicity, and volume. Time to implementation and time until protection is achieved are described. Long-term reliability for providing continued protection, including an assessment of potential for failure of the technology and the potential threats resulting from such a failure, also is evaluated.

6.1.2 Implementability

The technical implementability of each remedial technology or remedial alternative was evaluated in terms of technical feasibility and availability. Potential shortcomings and difficulties in construction, operations, and monitoring are presented and weighed against perceived benefits. Requirements for any post-implementation site controls such as LTM and land use restrictions are described. Details on administrative feasibility in terms of the likelihood of public acceptance and the ability to obtain necessary approvals are discussed.

6.1.3 Cost

The total cost (adjusted to present worth) of each remedial alternative was estimated for relative comparison. An estimate of capital costs, and operating and post-implementation costs for site monitoring and controls is included. An annual adjustment (discount) factor of 7 percent was assumed in present worth calculations. The annual adjustment factor is the difference between the rate of inflation and the cost of money (USEPA, 1993).

6.2 FACTORS INFLUENCING ALTERNATIVES DEVELOPMENT

Several factors were considered during the identification and screening of remedial technologies for addressing shallow groundwater contamination at the site. Factors considered included the objectives of the AFCEE natural attenuation demonstration program; contaminant, groundwater, and soil properties; current and future land uses; and potential receptors and exposure pathways. The following section briefly describes each of these factors and how they were used to narrow the list of potentially applicable remedial technologies to the final remedial alternatives considered for the study area.

6.2.1 Program Objectives

The intent of the RNA demonstration program sponsored by AFCEE is to develop a systematic process for scientifically investigating and documenting natural subsurface attenuation processes that can be factored into overall site remediation plans. The objective of this program and the specific demonstration at Columbus AFB is to provide solid evidence of RNA of dissolved fuel hydrocarbons and chlorinated solvents so that this information can be used to develop an effective groundwater remediation strategy. A secondary goal of this multi-site initiative is to provide a series of regional case studies that demonstrate that natural processes of contaminant degradation can often reduce contaminant concentrations in groundwater to below acceptable cleanup standards before completion of potential receptor exposure pathways.

Because the objective of this program is to study natural processes in the saturated zone rather than all contaminated media (e.g., soil, soil gas, etc.), technologies have been evaluated based primarily on their potential impact on shallow groundwater and phreatic soils. Technologies that can reduce vadose zone contamination and partitioning of contaminants into groundwater also have been evaluated. Many of the source removal technologies evaluated in this section also will reduce soil and soil gas contamination, but it is important to emphasize that the remedial alternatives developed in this document are not intended to remediate all contaminated media. Additional program objectives set forth by

AFCEE include cost effectiveness and minimization of waste. Technologies that may best meet these AFCEE criteria include institutional controls, soil vapor extraction (SVE), bioventing, bioslurping, passive drain collection, biosparging, and RNA. Under this program, slurry walls, sheet piling, carbon adsorption, and groundwater extraction with *ex situ* biological or chemical treatment of groundwater are not considered attractive technologies.

6.2.2 Contaminant Properties

The site-related contaminants considered as part of this demonstration in the study area are the BTEX compounds, TCE, DCE, VC, 1,1,1-TCA, 1,1-DCA, CB, and 1,2-DCB. Of these compounds, only benzene, TCE, VC, and CB are present in concentrations exceeding MCLs The primary sources of contamination at LF-06 are likely containers of waste scattered throughout the burial trenches; however, the exact location and nature of these sources is unknown.

The physiochemical characteristics of the individual compounds will greatly influence the effectiveness and selection of a remedial technology. Important characteristics for each of the compounds noted above are presented in the following paragraphs. These characteristics are listed for the purpose of a general comparison and a preliminary selection of remedial alternatives.

The BTEX compounds are generally volatile, highly soluble in water, and adsorb less strongly to soil than other hydrocarbons in a petroleum mixture. These characteristics allow the BTEX compounds to leach more rapidly from contaminated soil into groundwater, and to migrate as dissolved contamination (Lyman *et al.*, 1992). All of the BTEX compounds are highly susceptible to *in situ* degradation by both biotic and abiotic mechanisms.

Benzene is very volatile, with a vapor pressure of 76 millimeters of mercury (mm Hg) at 20°C and a Henry's Law Constant of approximately 0.0054 atmosphere-cubic meters per

mole (atm-m^3/mol) at 25°C (Hine and Mookerjee, 1975; Jury *et al.*, 1984). The solubility of pure benzene in water at 20°C has been reported to be 1,780 mg/L (Verschueren, 1983). Benzene is normally biodegraded to carbon dioxide, with catechol as a short-lived intermediate (Hopper, 1978; Ribbons and Eaton, 1992).

Toluene is also volatile, with a vapor pressure of 22 mm Hg at 20°C and a Henry's Law Constant of about 0.0067 atm-m^3/mol at 25°C (Pankow and Rosen, 1988; Hine and Mookerjee, 1975). Toluene sorbs more readily to soil media relative to benzene, but still is very mobile. The solubility of pure toluene in water at 20°C is approximately 515 mg/L at 20°C (Verschueren, 1983). Toluene has been shown to degrade to pyruvate, caetaldehyde, and completely to carbon dioxide via the intermediate catechol (Hopper, 1978; Wilson *et al.*, 1986; Ribbons and Eaton, 1992).

Ethylbenzene has a vapor pressure of 7 mm Hg at 20°C and a Henry's Law Constant of 0.0066 atm-m^3/mol (Pankow and Rosen, 1988; Valsaraj, 1988). Ethylbenzene sorbs more strongly to soils than benzene and toluene (Kenaga and Goring, 1980; Means *et al.*, 1980; Hassett *et al.*, 1983; Fetter, 1993). Pure ethylbenzene is also less soluble than benzene and toluene in water at 152 mg/L at 20°C (Verschueren, 1983; Miller *et al.*, 1985). Ethylbenzene ultimately degrades to carbon dioxide via its intermediate 3-ethylcatechol (Hopper, 1978; Ribbons and Eaton, 1992).

The three isomers of xylene have vapor pressures ranging from 7 to 9 mm Hg at 20°C and Henry's Law Constants of between 0.005 and 0.007 atm-m^3/mol at 25°C (Mackay and Wolkoff, 1973; Hine and Mookerjee, 1975; Pankow and Rosen, 1988). A compilation of literature values for sorption coefficients suggests that xylenes sorb to soil with approximately the same strength as ethylbenzene (Wiedemeier *et al.*, 1995). Pure xylenes have water solubilities of 152 to 160 mg/L at 20°C (Bohon and Claussen, 1951; Mackay and Shiu, 1981; Isnard and Lambert, 1988). Xylenes can degrade to carbon dioxide via pyruvate carbonyl intermediates (Hopper, 1978; Ribbons and Eaton, 1992).

The CAH compounds (e.g., TCE, DCE, VC, TCA, and DCA) are generally volatile, relatively soluble in water, and do not adsorb strongly to soil particles. These characteristics allow the CAHs to leach readily from NAPL and contaminated soil into groundwater, and to migrate as dissolved contamination (Lyman *et al.*, 1992). Many CAHs are amenable to *in situ* degradation by both biotic and abiotic mechanisms under certain geochemical conditions.

TCE is moderately volatile, with a vapor pressure ranging from 69 mm Hg to 74 mm Hg at 25°C (Mackay and Shiu, 1981; Klopffer *et al.*, 1988; Howard, 1990). Henry's Law Constants reported for TCE range from 0.0086 to 0.0102 atm-m^3/mol at 25°C (Ashworth *et al.*, 1988; Dewulf *et al.*, 1995). The solubility of pure TCE in water at 20°C has been reported to be 1,100 mg/L (Pearson and McConnell, 1975). TCE biodegradation products vary according to the prevailing groundwater geochemistry, and are described in Section 4.2.

cis-1,2-DCE is very volatile, with a vapor pressure of 200 mm Hg at 25°C and a Henry's Law Constant of about 0.0037 atm-m^3/mol. (reported in Wiedemeier *et al.*, 1996a). 1,1-DCE is also very volatile, with a vapor pressure of 591 mm of Hg at 25°C (Verschueren, 1983) and a Henry's Law Constant of 0.021 atm-m^3/mol (Schwille, 1988). DCE tends to be slightly more mobile than TCE, with less of a tendency to adsorb to the aquifer matrix material. The solubility of *cis*-1,2-DCE in water at 25°C is approximately 3,500 mg/L (Howard, 1990). The solubility of 1,1-DCE is about 2,500 mg/L (Howard, 1989). The degradation of DCE is discussed in Section 4.2.

Vinyl chloride is extremely volatile, with a vapor pressure of 2,580 mm of Hg at 20°C (Lyman *et al.*, 1982) and a Henry's Law Constant of 0.056 atm-m^3/mol at 25°C (Hine and Mookerjee, 1975). Vinyl chloride does not adsorb as well as either TCE or DCE (Karickhoff *et al.*, 1979). It is more mobile than TCE, DCE, and benzene in groundwater. The solubility of VC is about 1,100 mg/L at 25°C (Verschueren, 1983).

1,1,1-TCA is about as volatile as benzene, with a vapor pressure of 124 mm of Hg at 25°C and a Henry's Law Constant of about 0.008 atm-m^3/mol. (reported in Wiedemeier *et al.*, 1996a). 1,1,1-TCA is slightly more prone to adsorption than TCE (Howard, 1990). The solubility of 1,1,1-TCA in water at 25°C is about 1,495 mg/L (Howard, 1990).

Similar to DCE, 1,1-DCA is very volatile, with a vapor pressure of 227 mm of Hg at 25°C and a Henry's Law Constant of about 0.006 atm-m^3/mol (reported in Wiedemeier *et al.*, 1996a). 1,1-DCA is more mobile than TCA and DCE, but not as mobile as VC. The solubility of 1,1-DCA in water at 25°C is about 5,000 mg/L (Howard, 1989).

CB and DCB are less volatile and less soluble than CAHs, and are generally more likely to adsorb to soils. Their properties are generally similar to BTEX compounds. Under aerobic conditions, CB and DCB biodegrade in the same manner as benzene. Biodegradation of these compounds as substrates under anaerobic conditions has not been studied enough to have been documented in the scientific literature. However, the more chlorinated benzene compounds have been shown to undergo reductive dehalogenation.

CB is moderately volatile, with a vapor pressure of about 1.5 mm of Hg at 25°C and a Henry's Law Constant of about 0.0035 atm-m^3/mol (Howard, 1989). CB is relatively mobile, similar to the BTEX compounds. The solubility of CB in water at 25°C is about 472 mg/L (Howard, 1989).

1,2-DCB (also known as o-DCB) is slightly volatile, with a vapor pressure of 156 mm of Hg at 25°C and a Henry's Law Constant of about 0.0012 atm-m^3/mol at 20°C (Howard, 1990). It sorbs more strongly than the other chlorinated compounds discussed herein, with behavior similar to ethylbenzene or xylenes. The solubility of 1,2-DCB in water at 25°C is about 156 mg/L (Howard, 1990).

With the exception of TCE and 1,1,1-TCA, all of these compounds have been shown to be primary substrates for microbial metabolism. Simultaneous biodegradation of aliphatic,

aromatic, and alicyclic hydrocarbons has been observed. In fact, mineralization rates of hydrocarbons in mixtures, such as gasoline, may be faster than mineralization of the individual constituents as a result of cometabolic pathways (Jamison *et al.*, 1975; Perry, 1984). Moreover, during reductive dehalogenation, some of the compounds may be used as substrates/electron donors while others are used as electron acceptors.

On the basis of these physiochemical characteristics, RNA, biosparging, and groundwater extraction and treatment could all be effective options for collecting, destroying, and/or treating dissolved BTEX and chlorinated solvents at Site LF-06. Some of these options are considered less desirable after considering site-specific conditions (Section 6.2.3) and program objectives (Section 6.2.1).

6.2.3 Site-Specific Conditions

Three general categories of site-specific characteristics were considered when identifying remedial approaches for comparative evaluation as part of this demonstration. The first category was physical characteristics such as groundwater depth, hydraulic conductivity, gradient, flow direction, and soil type. The second category was the site geochemistry, or how the site contaminants are interacting with electron acceptors, microorganisms, and other site contaminants. Both of these categories influence the types of remedial technologies most appropriate for the site. The third category involved assumptions about future land use and potential receptor exposure pathways. Each of these site-specific characteristics has influenced the development of remedial alternatives included in the comparative evaluation.

6.2.3.1 Physical Characteristics

Site geology and hydrogeology have a profound effect on the transport of contaminants and the effectiveness and scope of required remedial technologies at a given site. Hydraulic conductivity is perhaps the most important aquifer parameter governing groundwater flow and contaminant transport in the subsurface. The velocity of the groundwater and dissolved contamination is directly related to the hydraulic conductivity of

the saturated zone. The estimated average advective groundwater velocity at LF-06 is 2.2 ft/day (800 ft/yr) (Section 3.3.2.4).

Although the relatively high hydraulic conductivities of the study area can result in greater plume expansion and migration, this same characteristic also can enhance the effectiveness of other remedial technologies, such as groundwater extraction, biosparging, and intrinsic remediation. For example, it should be less expensive and time-consuming to capture and treat a contaminant plume using a network of extraction wells in an area of high hydraulic conductivity because each well could envelope a larger area of influence and sustain a higher flow rate. The effectiveness of biosparging also may be increased in highly conductive and/or homogeneous aquifers because of reduced entry pressures and short-circuiting, and increased mixing of sparge air and groundwater. In addition, greater hydraulic conductivity would increase the amount of contaminant mass traveling through a biosparging network. Given a moderately high groundwater velocity, the effectiveness of natural attenuation can increase as a result of enhanced dilution and dispersion of the contaminant mass. The movement of contaminant mass within the subsurface away from the source area also can bring contaminants into contact with a larger mass of electron donors and acceptors, thereby increasing rates of biodegradation.

Like hydraulic conductivity, the organic carbon content of native phreatic zone soils can influence the effectiveness of remedial alternatives. The soils across the phreatic surface in the study area have a low organic carbon content (less than 0.06 percent), and therefore, the soils have a correspondingly low sorptive potential. However, sorptive capacity where soil TOC is greater than 0.01 percent is typically sufficient to cause a difference in the groundwater and contaminant velocities. The difference between contaminant and groundwater velocity increases the effectiveness of biodegradation in the source area because there are fresh electron acceptors flowing past the slower moving dissolved contaminant mass.

6.2.3.2 Geochemical Characteristics

To satisfy the requirements of indigenous microbial activity and RNA, the aquifer also must provide an adequate and available carbon or energy source (e.g., fuel hydrocarbon contamination), electron acceptors, essential nutrients, and proper ranges of pH, temperature, and redox potential. Data collected as part of the field work phase of this demonstration project and described in Sections 3 and 4 of this TS indicate that this site is characterized by adequate and available carbon/energy sources and electron acceptors to support measurable biodegradation of fuel hydrocarbon contamination by indigenous microorganisms. DO, nitrate, ferric iron, sulfate, and carbon dioxide represent sources of significant electron acceptor capacity for the biodegradation of organic compounds at LF-06.

The average pH in shallow site groundwater ranged between 4.3 and 6.8 standard units in November 1996, which is within to slightly below the optimal range for biodegradation of 6 to 8 standard pH units (Wiedemeier *et al.*, 1995). As pH values drop below 6 standard units, bacteria populations can be expected to decrease, which in turn may reduce the rate of hydrocarbon biodegradation. Redox potentials ranged from -300 to 284 mV in November 1996 (Figure 4.14), and suggest a groundwater environment that is both oxidizing and reducing. The redox potentials at the site suggest that aerobic biodegradation, nitrate reduction, iron (II) reduction, sulfate reduction, and methanogenesis (consistent with observed geochemical indicator trends discussed in Section 4) would reduce contaminant concentrations in groundwater. Groundwater data presented in Section 4 strongly support the conclusion that aerobic and anaerobic processes are reducing BTEX contamination given the current geochemical conditions. These same processes also appear to be acting upon chlorinated solvents, both as electron donors and electron acceptors.

Microbe addition was not considered a viable remedial approach for this site on the basis of observed geochemical trends that suggest that significant microbial activity is

likely occurring. Hydrocarbon-degrading microorganisms are ubiquitous in the subsurface, and a large number of hydrocarbon-degrading isolates (bacteria and fungi) have been discovered in different soil environments (see Wiedemeier *et al.*, 1995 and 1996a for a partial listing). Indigenous microorganisms have a distinct advantage over microorganisms injected into the subsurface to enhance biodegradation because indigenous microorganisms are well adapted to the physical and chemical conditions of the subsurface in which they reside (Goldstein *et al.*, 1985).

6.2.3.3 Potential Receptor Exposure Pathways

A pathways analysis identifies the potential human and ecological receptors that could come into contact with site-related contamination and the pathways through which these receptors might be exposed. To have a completed exposure pathway, there must be a source of contamination, a potential mechanism(s) of release, a pathway of transport to an exposure point, an exposure point, and a receptor. If any of these elements do not exist, the exposure pathway is considered incomplete, and receptors will not come into contact with site-related contamination. Evaluation of the potential long-term effectiveness of any remedial technology or remedial alternative as part of this demonstration project includes determining the potential for pathway completion. If a completed exposure pathway exists (e.g., surface water contact), potential long-term remedial options may still be sufficient to maintain exposure concentrations below regulatory action levels. Establishing site-specific, risk-based cleanup levels is beyond the scope of this TS.

Assumptions about current and future land uses at a site form the basis for identifying potential receptors, potential exposure pathways, reasonable exposure scenarios, and appropriate remediation goals. USEPA (1991) advises that the land use associated with the highest (most conservative) potential level of exposure and risk that can reasonably be expected to occur should be used to guide the identification of potential exposure pathways and to determine the level to which a site must be remediated. Because the site is near recreational facilities for a secured military Base and covered by grass and trees, Base

workers and their families are the most probable potential receptors that could be exposed to any site-related contamination.

There are two Base water supply wells located approximately 1 mile west of Site LF-06, but both of these wells are screened nearly 400 feet bgs in the confined regional aquifer. The surface water drainage south of the landfill could be another potential exposure point for human and/or ecological receptors; however, groundwater elevation data and contaminant plume configurations suggest that site groundwater flow is predominantly to the west. Several residential wells lie within 0.5 mile of Site LF-06 to the south and southeast. One of the residential wells in the area was drilled to a depth of 165 feet, but the screen is at a depth of 54 feet. Depth and casing information is unavailable for the other residential wells in the area, but the residential wells could draw from the shallow aquifer. Given the groundwater flow direction, however, it is unlikely that residential wells would be impacted by groundwater contamination from LF-06.

6.2.3.4 Remediation Goals for Shallow Groundwater

The federal MCLs as listed in 40 CFR 141-61(a) for BTEX and other VOCs are adopted as the state water quality MCLs by the MDEQ (MDEQ Office of Pollution Control, Groundwater Division, Groundwater Quality Standards, Section 3, Numerical Groundwater Standards). MCLs for compounds of potential concern detected in LF-06 groundwater are presented in Table 6.1. Although it is unlikely that groundwater from Site LF-06 would be ingested by humans because there are no current downgradient water supplies in close proximity to the site and the Base is converting to a City supply system in the near future, the state MCLs will be used to evaluate the effectiveness, implementability, and cost of remedial alternatives in this TS.

For this TS, the primary remedial objective for evaluation of remediation technologies for shallow groundwater is to reduce contaminant concentrations in groundwater to below state regulatory criteria at a downgradient sentry well. To accomplish this, remedial alternatives focus on limiting migration of dissolved contaminant concentrations exceeding

MCLs away from Site LF-06 and (possibly) towards the Base boundary. Source remediation was not considered because the source areas are not well-defined.

TABLE 6.1
GROUNDWATER QUALITY STANDARDS
LF-06 RNA TS
COLUMBUS AFB, MISSISSIPPI

Compound	State Maximum Contaminant Level (µg/L)[a/]
Benzene	5
Trichloroethylene	5
Vinyl Chloride	2
Chlorobenzene	100

[a/] Source: MDEQ Office of Pollution Control, Groundwater Division, Groundwater Quality Standards, Section 3, Numerical Groundwater Standards.

Available data suggest that there are no completed exposure pathways involving human and ecological receptors exposed to contaminated groundwater under current conditions. Site LF-06 is part of a secured military base, so institutional controls can be incorporated to limit any future intrusive activity at the site. The required period of any groundwater and soil institutional controls associated with the selected remedial alternative is likely to expire before any anticipated future land use changes. Off-base migration of dissolved contaminants in concentrations exceeding MCLs appears unlikely, given the groundwater flow direction and observed concentrations. Also, analytical model results suggest that the contaminant plumes have reached a steady-state configuration and that significant migration of contaminant concentrations exceeding MCLs beyond the observed plume extents is unlikely.

6.2.4 Summary of Remedial Option Screening

Several remedial options have been identified and screened for use in treating the shallow groundwater at the site. Table 6.2 identifies the initial remedial technologies and

approaches considered as part of this demonstration and those retained for detailed comparative analysis. Screening was conducted systematically by considering the program objectives of the AFCEE RNA demonstration, physiochemical properties of groundwater contaminants detected at LF-06, and other site-specific characteristics such as hydrogeology, geochemistry, land use assumptions, potential receptor exposure pathways, and appropriate remediation goals. All of these factors will influence the technical effectiveness, implementation, and relative cost of technologies for remediating shallow groundwater underlying and migrating from the site. The remedial options retained for development of remedial alternatives and comparative analysis include institutional controls, natural attenuation, LTM, biosparging, air sparging, groundwater extraction, and air stripping for treatment of extracted groundwater.

6.3 BRIEF DESCRIPTION OF REMEDIAL ALTERNATIVES

This section describes how remedial technologies retained from the screening process were combined into three remedial alternatives for the study area. Sufficient information on each remedial alternative is provided to facilitate a comparative analysis of effectiveness, implementability, and cost in Section 6.4.

6.3.1 Alternative 1 - RNA and Institutional Controls with Long-Term Groundwater Monitoring

RNA is achieved when natural attenuation mechanisms bring about a reduction in the total mass of a contaminant in the soil or dissolved in groundwater. RNA results from the integration of several subsurface attenuation mechanisms that are classified as either destructive or nondestructive. Destructive attenuation mechanisms include biodegradation, abiotic oxidation, and hydrolysis. Nondestructive attenuation mechanisms include sorption, dilution (caused by dispersion and infiltration), and volatilization. In some cases,

TABLE 6.2
INITIAL TECHNICAL IMPLEMENTABILITY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER REMEDIATION
LF-06 RNA TS
COLUMBUS AFB, MISSISSIPPI

General Response Action	Technology Type	Process Option	Implementability	Effectiveness	Relative Cost	Retain
Long-Term Monitoring	Periodic Groundwater Monitoring	Confirmation Wells	Many wells and monitoring points are available to confirm the progress of remediation. Sufficient space exists for additional wells.	Necessary for all remedia-tion strategies	Low	Yes
		Point-of-Compliance Wells	Sufficient distance exists between the plume and point-of-compliance to locate several wells.	Necessary	Low	Yes
Institutional Controls	Groundwater Use Control	Land Use Control/Regulate Well Permits	The plume lies within the base boundary, and land and groundwater use are under base jurisdiction.	Necessary	Low	Yes
		Seal/Abandon Existing Wells	No production wells are known to exist in the current or predicted plume area.	Not required at this site	Low	No
		Point-of-Use Treatment	No shallow groundwater is extracted from the plume area for any use.	Low	Moderate	No
	Public Education	Meetings/ Newsletters	Base public relations and environmental management offices have many information avenues to workers and residents.	Necessary	Low	Yes
Containment of Plume	Hydraulic Controls	Interceptor Trench Collection	No likely receptors immediately downgradient of site. Size of plume and hydraulic conductivity of site soils favors pumping.	Moderate to High	Moderate	No
		Groundwater Extraction	Would prevent downgradient migration of dissolved contaminants, including off-site migration.	Moderate to High	Moderate	Yes
	Physical Controls	Slurry Walls/Grout Curtains	Although implementable, the technology would be costly and less effective because of high groundwater velocity and consequently large groundwater volume.	Low	High	No
		Sheet Piling	Although implementable, the technology would be costly and less effective because of high groundwater velocity and consequently large groundwater volume.	Low	High	No
	Reactive/ Semi-Permeable Barriers	Biologically Active Zones	Degradation of contaminants can be stimulated by allowing groundwater to flow through a nutrient-rich barrier. Although implementable, the technology is new and relatively costly unless concentrations are high.	Moderate	High	No

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TABLE 6.2 (continued)
INITIAL TECHNICAL IMPLEMENTABILITY SCREENING OF
TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER REMEDIATION
LF-06 RNA TS
COLUMBUS AFB, MISSISSIPPI

General Response Action	Technology Type	Process Option	Implementability	Effective-ness	Relative Cost	Retain
In Situ Groundwater Treatment	Biological	Oxygen and/or Nutrient-Enhanced Biodegradation (Biosparging)	Oxygen and/or nutrients are injected downgradient of plume to limit plume migration by enhancing biodegradation of BTEX, DCE, DCA, VC, CB, and/or DCB and reducing contaminant concentrations through volatilization. Implementable, and technology may enhance natural attenuation processes for most compounds. However, compounds such as TCE and 1,1,1-TCA do not biodegrade under aerobic conditions.	Moderate	Low	Yes
	Chemical/ Physical	Natural Attenuation	A combination of natural biological, chemical, and physical removal mechanisms which occur to varying degrees on every site. Groundwater sampling at LF-06 indicates that this is an ongoing remediation process.	High	Low	Yes
		Air Sparging (Volatilization)	Injection of air into contaminated aquifer creating a mass transfer of contamination into air bubbles and vadose zone. Similar to biosparging in effectiveness; however, more mass is transferred than destroyed.	Moderate	Low	Yes
Source Removal/ Groundwater Remediation	Groundwater Extraction	Vertical Pumping Wells	Source area of groundwater plume is pumped by installing submersible pumps in source area wells. Limited by contaminant mass transfer rates into the groundwater; therefore, for steady-state or shrinking plumes it is comparably effective to RNA.	Moderate	Moderate	No
Aboveground Groundwater Treatment	Biological	Bioreactors	High flow rates require excessive retention times and large reactors. Volatile hydrocarbons are often volatilized in these systems.	Moderate	High	No
	Chemical/ Physical	Air Stripping	Cost-effective technology for removing volatile hydrocarbons from groundwater at high flow rates. Potential permitting for air emissions.	High	Moderate	Yes
		Activated Carbon	Cost prohibitive for more concentrated hydrocarbons, and does not remove VC. Creates a carbon disposal problem.	Moderate	High (O&M)	No
		Direct Discharge to Industrial Waste Water Treatment Plant (IWWTP)	Implementable option only when an IWWTP is readily available and capable of handling BTEX, TPH, chlorinated solvent, and hydraulic loading. IWWTP not available for this site.	High	Low	No
		UV/Ozone Reactors	High flow rates require lengthy retention times and large, costly reactors.	Moderate	High	No

TABLE 6.2 (concluded)
INITIAL TECHNICAL IMPLEMENTABILITY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER REMEDIATION
LF-06 RNA TS
COLUMBUS AFB, MISSISSIPPI

General Response Action	Technology Type	Process Option	Implementability	Effectiveness	Relative Cost	Retain
Treated Groundwater Disposal	Discharge to IWWTP or Sanitary Sewer	IWWTP	Implementable option only when an IWWTP is available and capable of handling hydraulic loading. IWWTP is not available.	High	Low	No
		Sanitary Sewer	Implementable option only when access to a sanitary sewer exists and hydraulic loading is acceptable.	High	Low	Yes
	Treated Groundwater Reinjection	Vertical Injection Wells	Injection wells subject to clogging, high maintenance, and permitting.	Moderate	Moderate	No
		Injection Trenches	Requires large trenches and can be subject to injection well permitting.	Moderate	Moderate	No
	Discharge to Surface Waters	Storm Drains	Generally requires NPDES or other discharge permit	High	Low	Yes
Source Removal/Soil Remediation	Excavation/ Treatment	Landfilling	For reasons of risk and cost reduction, in-situ methods preferable when possible. Sources are widely distributed and locations are poorly defined.	Moderate	Moderate	No
		Biological Landfarming	For reasons of risk and cost reduction, in-situ methods preferable when possible. Sources are widely distributed and locations are poorly defined.	Moderate	Moderate	No
		Thermal Desorption	For reasons of risk and cost reduction, in-situ methods preferable when possible. Sources are widely distributed and locations are poorly defined.	Moderate	High	No
	In Situ	Bioventing	Air injection/extraction to increase soil oxygen levels and stimulate biodegradation of fuel residuals. Sources are widely distributed and locations are poorly defined. Not a proven treatment for chlorinated solvents.	Moderate to High	Low	No
		Soil Vapor Extraction	Vapor extraction has been successfully implemented at other sites. Highly implementable in sandy soils and effective for volatiles in unsaturated soils. May be subject to air permitting. Sources are widely distributed and locations are poorly defined.	High	Low to Moderate	No
		Soil Washing	Water and/or surfactant solution are forced through zones of residual contamination to enhance contaminant partitioning into the groundwater. Most effective in homogeneous sandy soils. Sources are widely distributed and locations are poorly defined.	Low	High	No

RNA will reduce dissolved contaminant concentrations below numerical concentration goals intended to be protective of human health and the environment. As indicated by the evidence of RNA described in Section 4, these processes are occurring in the vicinity of LF-06 and will continue to reduce contaminant mass in the plume area. Moreover, most contaminant concentrations are below MCLs or only slightly above MCLs.

Results of an analytical contaminant transport model suggest that the concentrations of the groundwater contaminant plume emanating from LF-06 will drop below MCLs within, at most, 305 meters (1,000 feet) downgradient from the edge of the landfill. VC and benzene are the most likely to migrate that far, as supported by both modeled and observed results showing widespread diffused concentrations. TCE and CB are likely to migrate less far before dropping below MCLs, largely due to greater sorption relative to benzene and VC. These results also suggest that the observed conditions represent a steady-state plume, because the distances from the wells with the highest concentrations of the modeled compounds to the downgradient plume extents is at most about 1,300 feet. The observed contaminant plumes are therefore unlikely to grow more than 100 feet longer. These results are conservative because they assume the source of contamination will maintain a constant strength over time, while the sources may decrease due to weathering (loss of mass to dissolution, volatilization, and biodegradation).

Implementation of Alternative 1 would require the use of institutional controls such as land use restrictions and LTM. Land use restrictions may include placing long-term restrictions on soil excavation within the source area and long-term restrictions on groundwater well installations within and downgradient from the plume area. The intent of these restrictions would be to reduce potential receptor exposure to contaminants by legally restricting activities within areas affected by site-related contamination.

Long-term monitoring would be performed at a regular frequency and would consist of sampling a set of wells, including upgradient, source area, plume extent, and sentry wells.

For this site, it is assumed that 10 years of annual monitoring would be needed to establish that the plume is stable or shrinking and that contaminant concentrations are decreasing. The site- and alternative-specific LTM strategy is provided in Section 7. On the basis of predictive contaminant fate and transport model results (Section 6.4), it is unlikely that contaminant concentrations exceeding MDEQ groundwater MCLs would approach a potential receptor exposure point. Nevertheless, LTM is the technical mechanism used to evaluate the progress of natural attenuation processes and to ensure that remedial objectives are being met. Detection of benzene, TCE, VC, or CB in excess of their individual MDEQ MCLs at any sentry well may require additional evaluation to assess contaminant migration and to determine the probable extent of migration, or to determine if additional corrective action is necessary. In either case, land use restrictions would require reevaluation.

Public education on the selected alternative would be developed to inform Base personnel and residents of the scientific principles underlying source reduction and RNA. This education could be accomplished through public meetings, presentations, press releases, and posting of signs where appropriate. Periodic site reviews also could be conducted every year using data collected from the long-term groundwater monitoring program. The purpose of these periodic reviews would be to evaluate the extent of contamination, assess contaminant migration and attenuation through time, document the effectiveness of source removal and/or institutional controls at the site, and reevaluate the need for additional remedial actions at the site.

6.3.2 Alternative 2 - Biosparging, RNA, and Institutional Controls with Long-Term Groundwater Monitoring

This alternative is identical to Alternative 1 except that a sparging system would be used to minimize downgradient migration of dissolved contamination by placing a line of sparging wells perpendicular to the observed groundwater flow direction near the downgradient end of the contaminant plume(s). Biosparging is used to enhance the biodegradation of organic contaminants in subsurface soils and groundwater by supplying

oxygen to indigenous microbes using low-flow air injection. Some volatilization of contaminants may occur, but the biosparging system is intended to be operated at a low rate of air injection that significantly reduces emissions into the atmosphere while maximizing *in situ* biodegradation. Air sparging uses higher air flow rates to volatilize contaminants, although some biodegradation also will occur.

If it is determined that the low flow rates for a biosparging system would not be sufficient and that removal of contaminant mass would be improved by substantially increasing the air injection rate, air sparging could be promoted by simply increasing air flow rates. In this case, a SVE system may be needed to recover and treat soil vapors prior to discharge to the atmosphere. However, regardless of which system is implemented, SVE is not likely to be needed due to the low dissolved contaminant concentrations. Because no source reduction is included, biosparging/air sparging will not appreciably reduce the time required for RNA to reduce contaminant concentrations upgradient from the sparging system.

On the basis of Parsons ES' experience in the application of biosparging technology, a line of 45 vertical air injection wells should be sufficient to prevent dissolved groundwater contamination from migrating further downgradient from LF-06. Approximately 5 shallow vapor monitoring points also would be installed for measurement of the injection wells effectiveness. The conceptual design assumes that biosparging points would be 30 feet deep with 5 feet of screen between about 15 and 20 feet beneath the water table. Biosparging wells also are assumed to have an approximate radius of influence of 10 feet. To estimate the cost of remediation, it was assumed that the biosparging system would be operated for 10 years because, as with Alternative 1, it may take that long to establish the long-term concentration trends in the area upgradient of the sparge line.

As with Alternative 1, institutional controls and LTM would be required. Sentry and LTM wells would be the same as described for Alternative 1. Annual monitoring would

be performed for a total of 10 years to verify that no contaminant concentrations exceeding MCLs migrate downgradient from the sparge line.

6.3.3 Alternative 3 - Groundwater Extraction and Treatment, RNA, and Institutional Controls with Long-Term Groundwater Monitoring

Groundwater extraction at Site LF-06 could be performed for contaminant plume containment rather than sparging. Eight 10-inch groundwater extraction wells would be placed near the downgradient margin of the contaminant plume, along a line perpendicular to the observed groundwater flow direction. The groundwater extraction system will prevent contaminated groundwater from migrating downgradient from LF-06 and prevent completion of any potential receptor pathways. Given the relatively high natural groundwater velocity at the site (which will be further increased by pumping), pumping should rapidly capture much of the water within the plume. It is therefore estimated that the pumping system would only need to operate for 5 years before it can be shut down and LTM can begin.

Because groundwater extraction is not proposed for source reduction it may not appreciably reduce the predicted length of time required for RNA to complete groundwater remediation upgradient of the extraction system. If contaminant concentrations drop rapidly, the system could be shut off, but monitoring would have to continue to see if concentrations rebound after pumping ceases. In addition, because groundwater extraction potentially generates a large volume of waste requiring treatment (via air stripping) and disposal, the alternative does not comply well with the objectives of this AFCEE initiative.

As with Alternative 1, institutional controls and LTM would be required. LTM wells would be the same as described for Alternative 1. LTM should continue for an additional 5 years after pumping ceases to verify that concentrations do not rebound above MCLs and to establish plume behavior patterns created by pumping.

6.4 EVALUATION OF ALTERNATIVES

This section provides a comparative analysis of each of the remedial alternatives based on the effectiveness, implementability, and cost criteria. A summary of this evaluation is presented in Section 6.5.

6.4.1 Alternative 1 - RNA and Institutional Controls with Long-Term Groundwater Monitoring

6.4.1.1 Effectiveness

Alternative 1 is based on the effectiveness of natural processes that minimize contaminant migration and reduce contaminant mass over time, and the effectiveness of institutional controls. The effectiveness of RNA was evaluated through the analytical modeling presented in Section 5. Model results suggest that natural attenuation mechanisms are limiting contaminant migration and analysis of chemical data suggests that those mechanisms are reducing contaminant mass and toxicity. Contaminant (i.e., benzene, TCE, VC, and CB) concentrations should not exceed state MCLs at the sentry wells. Groundwater monitoring at the LTM and sentry wells will allow for continued evaluation of contaminant migration and ensure the safety of this alternative. While this alternative would not cease to be protective if the contaminant concentrations exceeding MCLs were detected in the sentry wells, such an instance would indicate that site conditions should be reevaluated.

The effectiveness of this remedial alternative requires that future intrusive site activities or construction activities within the plume area be conducted only by properly protected site workers. Reasonable land use assumptions for the plume area indicate that exposure is unlikely unless excavation or drilling activities bring groundwater or saturated soil to the surface. Long-term land use restrictions would be required to ensure that shallow groundwater is not pumped or removed for potable use within about 500 feet from the margins of the existing contaminant plume. Existing health and safety plans should be

enforced to reduce worker exposures during additional excavation or installing and monitoring additional wells.

Compliance with program goals is one component of the long-term effectiveness evaluation criterion. Alternative 1 would satisfy program objectives designed to promote RNA as a component of site remediation and to scientifically document natural processes. In addition, the alternative satisfies waste minimization goals as only limited drill cuttings would be generated during construction of new monitoring wells. This alternative also satisfies the program goal for cost effectiveness.

Apart from the administrative concerns associated with the enforcement of long-term land use restrictions and long-term groundwater monitoring programs, this remedial alternative should provide reliable, continued protection. It is assumed that dissolved contaminant concentrations will exceed state and federal criteria throughout the plume for approximately 10 years under Alternative 1. Furthermore, it is assumed that sampling will be performed every year for 10 years to demonstrate that RNA is reducing dissolved contaminant concentrations to levels below regulatory criteria and limiting plume migration.

6.4.1.2 Implementability

Alternative 1 is not technically difficult to implement. Installation of any additional LTM wells and monitoring of groundwater are standard procedures. Long-term management efforts would be required to ensure proper sampling procedures are followed. Periodic site reviews should be conducted to confirm the adequacy and completeness of LTM data and verify the effectiveness of this remediation approach. There also may be administrative concerns associated with long-term enforcement of groundwater use restrictions. Future land use within the source area may be impacted by leaving contaminated soil and groundwater in place. However, with the exception of any subsurface work at the site, the risk for Base personnel of exposure to contaminants will be limited. If required, the public and the regulators would have to be informed of the

benefits and limitations of the RNA option. Educational programs are not difficult to implement. Where the effectiveness of this option has been supported, the initial regulatory reaction to this alternative has been positive.

6.4.1.3 Cost

The cost of Alternative 1 is summarized in Table 6.3. Capital costs are limited to the construction of 4 new LTM wells and 2 new sentry wells. Included in the $182,635 total present worth cost estimate for Alternative 1 are the costs of maintaining institutional controls and long-term groundwater monitoring at 14 LTM and sentry wells for a total of 10 years. If the dissolved contaminant concentrations at the site decrease rapidly or drop below MCLs for consecutive sampling events, then monitoring may be reduced or eliminated. Conversely, significant increases for consecutive sampling events or a significant increase in plume extent could warrant an increase in sampling frequency or implementation of another remedial alternative.

TABLE 6.3
ALTERNATIVE 1 - COST ESTIMATE
SITE LF-06 RNA TS
COLUMBUS AFB, MISSISSIPPI

Capital Costs	**Cost**
Design/Construct 6 LTM/Sentry Wells	$21,201
Monitoring Costs (per Sampling Event)	**Cost per Event**
Conduct Groundwater Sampling at 14 wells (annually for 10 years)	$13,435
Maintain Institutional Controls/Public Education (10 years)	$5,000
Project Management and Reporting (10 years)	$4,747
Present Worth of Alternative 1 [a/]	**$182,635**

[a/] Based on an annual adjustment (discount) factor of 7 percent (USEPA, 1993).

6.4.2 Alternative 2 - Biosparging, RNA, and Institutional Controls with Long-Term Groundwater Monitoring

6.4.2.1 Effectiveness

The effectiveness of RNA and institutional controls with LTM is discussed for Alternative 1 in Section 6.4.1.1. Biosparging and sparging are established technologies for reducing contaminant concentrations and controlling plume migration. The goal of sparging would be to prevent dissolved contaminant concentrations that exceed MCLs from moving downgradient of the site. Although it is not likely to be needed, an SVE could be coupled with sparging to prevent migration of contaminated vapors from the system. It should be noted that problems such as channeling, which consists of preferential migration of injected air along specific, more permeable, flow paths rather than uniform air dispersal in the zone surrounding the injection screen, have been cited. However, the potential for significant channeling in the sandy deposits of the unconfined surficial aquifer is reduced.

Alternative 2 should provide reliable, continuous protection with little risk from temporary system failures. This alternative also complies with AFCEE program goals because RNA remains the predominant remediation method for contaminants dissolved in groundwater at the site, with sparging serving to limit plume migration. This remedial alternative, however, will result in the generation of additional contaminated soil that may require treatment and/or disposal. Furthermore, if an SVE system is installed, off-gas from the SVE system may require expensive treatment prior to atmospheric release.

6.4.2.2 Implementability

Installing and operating a biosparging system to prevent downgradient contaminant migration is more complex than Alternative 1; however, major obstacles are not anticipated. Installation of the sparging system involves standard engineering design and construction, including the installation of air injection wells, a regenerative blower system (1 high-capacity blower), electrical supply, and system integration.

Installation and operation of a biosparging system would require an increased commitment of labor hours and other resources to maintain and monitor the system. Periodic maintenance would be required for the regenerative blowers. Weekly system checks are recommended, and operating data such as injection pressures and flow rates would be manually recorded. It is estimated that the biosparging system would be operational for 10 years. In addition, an air emissions permit may need to be obtained prior to system start-up. The technical and administrative implementability concerns associated with the natural attenuation and LTM components of this remedial alternative are similar to those discussed for Alternative 1.

6.4.2.3 Cost

The estimated capital and operating costs of Alternative 2 are shown in Table 6.4. The total present worth cost of Alternative 2 is $814,505. The cost of Alternative 2 is increased from the costs of Alternative 1 by the addition of the biosparging system, including system design, construction, operation, and maintenance. It is assumed that the biosparging system would operate for 10 years after installation. LTM is assumed to occur every year for 10 years to ensure that natural attenuation is reducing contaminant concentrations to below regulatory criteria throughout the groundwater plume during and after sparging system operation. The capital expense and annual costs for LTM and institutional controls are assumed to be the same as for Alternative 1. Should SVE be necessary, the costs will increase due to the additional equipment and monitoring that would be required.

6.4.3 Alternative 3 -Groundwater Extraction, RNA, and Institutional Controls with Long-Term Groundwater Monitoring

6.4.3.1 Effectiveness

Groundwater extraction is an established technology for controlling plume migration. The extraction of contaminated groundwater will prevent plume migration away from LF-06, thereby preventing any completion of potential exposure pathways. Simulation of

TABLE 6.4
ALTERNATIVE 2 - COST ESTIMATE
SITE LF-06 RNA TS
COLUMBUS AFB, MISSISSIPPI

Capital Costs	Cost
Design/Construct 6 LTM/Sentry Wells	$21,201
Design/Construct Biosparging System	$234,925
Operation, Maintenance, and Monitoring Costs	**Cost per annum or event**
Operate and Maintain Biosparging System (10 years)	$50,840
Annual Sparge System Report (10 years)	$5,676
Conduct Groundwater Sampling at 14 wells (annually for 10 years)	$13,435
Maintain Institutional Controls/Public Education (10 years)	$5,000
Project Management and Reporting (10 years)	$4,747
Present Worth of Alternative 2 [a/]	**$814,505**

[a/] Based on an annual adjustment (discount) factor of 7 percent (USEPA, 1993).

the effect of groundwater extraction was not performed; however, the method of Javandel and Tsang (1986) was used to estimate the number of wells and the pumping rates needed to effect plume capture. Because source reduction is not occurring, remediation time is assumed to be the same as for the other remedial alternatives.

Alternative 3 should provide reliable, continuous protection for downgradient receptors. This alternative, however, does not comply well with all of the AFCEE program goals because of the generation of soil and water waste requiring treatment and disposal. This is especially true because the high hydraulic conductivity of site sediments requires relatively high pumping rates (totaling about 1,800 gallons per minute) to effect plume capture. The

high pumping rates result in a greater volume of water to treat and dispose. In addition, contaminants are not destroyed, but are instead transferred to another phase that may require further treatment. As with Alternatives 1 and 2, this alternative would rely on RNA with LTM and institutional controls to remediate the contaminated groundwater once the extraction system is shut down.

6.4.3.2 Implementability

Groundwater extraction would be labor intensive and expensive to implement. The option would require additional site investigation, design and engineering, installation, and a weekly commitment to operation and maintenance of the extraction and air stripper systems. An air emissions permit may need to be obtained for the air stripper prior to system start-up. A permit also may be needed for disposal of treated groundwater. The technical and administrative implementability concerns associated with the RNA, LTM, and institutional controls of this remedial alternative are similar to those discussed for Alternatives 1 and 2.

6.4.3.3 Cost

The estimated capital and operating costs of Alternative 3 are shown in Table 6.5. The total present-worth cost of Alternative 3 is $849,348. Despite the shorter operating time frame, the cost of Alternative 3 is comparable to the costs of Alternative 2 because it is more costly to design, install, operate, and maintain the groundwater extraction system. However, the cost could be significantly higher if off-gas treatment for the air stripper is required, if the system has to run for more than 5 years, or if treated groundwater cannot be easily disposed (e.g., discharged to a storm sewer). The annual costs for LTM and institutional controls are assumed to be the same as for Alternatives 1 and/or 2. The resulting present-worth cost for LTM and institutional controls are the same as for Alternative 1 because it is assumed that the groundwater extraction system merely contains the contaminant plume without treating the source, and therefore, will operate for the same length of time.

TABLE 6.5
ALTERNATIVE 3 - COST ESTIMATE
SITE LF-06 RNA TS
COLUMBUS AFB, MISSISSIPPI

Capital Costs	**Cost**
Design/Construct 6 LTM/Sentry Wells	$21,201
Design/Construct/Install Groundwater Extraction and Treatment System	$424,507
Operation, Maintenance, and Monitoring Costs	**Cost per annum or event**
Conduct Groundwater Sampling at 14 wells (annually for 10 years)	$13,435
Maintain Groundwater Extraction System (5 years)	$58,340
Maintain Institutional Controls/Public Education (10 years)	$5,000
Project Management and Reporting (10 years)	$4,747
Present Worth of Alternative 3 [a/]	**$849,348**

[a/] Based on an annual adjustment (discount) factor of 7 percent (USEPA, 1993).

6.5 RECOMMENDED REMEDIAL APPROACH

Three remedial alternatives have been evaluated for remediation of the shallow groundwater at the study area. Components of the alternatives evaluated include biosparging, groundwater extraction with *ex-situ* treatment, RNA with LTM of groundwater, and institutional controls. Table 6.6 summarizes the results of the evaluation based upon effectiveness, implementability, and cost criteria. Owing to the low contaminant concentrations and the high cost of engineered alternatives, the Air Force recommends Alternative 1 as the most cost-effective option for risk reduction at the study area.

All three alternatives make use of natural attenuation mechanisms to reduce plume migration and toxicity, although Alternative 3 relies more on capture of the plume with the

TABLE 6.6
SUMMARY OF REMEDIAL ALTERNATIVES EVALUATION FOR GROUNDWATER REMEDIATION
SITE LF-06 RNA TS
COLUMBUS AFB, MISSISSIPPI

Remedial Alternative	Effectiveness	Implementability	Present-Worth Cost Estimate
Alternative 1			
- Natural Attenuation - Long-Term Monitoring - Institutional Controls	Contaminant mass, volume, and toxicity will be significantly reduced and plume is unlikely to spread. MCLs are not likely to be exceeded at sentry wells.	Readily implementable. Long-term management, groundwater use controls, and monitoring required for an estimated 10 years. If MCLs are exceeded at sentry wells, additional remedial work may be required.	$179,516
Alternative 2			
- Sparging - Natural Attenuation - Long-Term Monitoring - Institutional Controls	Similar to Alternative 1, with the addition of biosparging system. Contaminant mass, volume, and toxicity would not be reduced more rapidly than in Alternative 1. SVE system may be needed to treat contaminated vapors forced into soil from sparging activities.	Readily implementable. Installation of biosparging/SVE system should present no problems. Biosparging estimated to continue for 10 years. Long-term management, groundwater controls, and monitoring required for an estimated 10 years. If MCLs are exceeded at sentry wells, additional remedial work may be required.	$814,505
Alternative 3			
- Groundwater Extraction - Natural Attenuation - Long-Term Monitoring - Institutional Controls	Similar to Alternative 1, with the addition of a groundwater extraction system. Contaminant mass, volume, and toxicity will not be reduced more rapidly than in Alternative 1; however, migration of dissolved contaminants downgradient from the site will be prevented.	Readily implementable. Installation and operation of groundwater extraction system will be costly and labor intensive. Groundwater extraction estimated to continue for 5 years. Long-term management, groundwater controls, and monitoring required for an estimated 10 years. If MCLs are exceeded at sentry wells, additional remedial work may be required.	$846,229

extraction system. In addition, Alternatives 2 and 3 would use active *in situ* and *ex situ* techniques to limit contaminant migration. Implementation of Alternatives 2 and 3 would not substantially decrease the time frame for remediation, but both alternatives would require greater capital expenditures. Alternatives 2 and 3 are considered less favorable because in part they simply transfer contamination to a different medium rather than reducing contaminants to innocuous byproducts.

All three remedial alternatives are implementable and effectively reduce potential contaminant migration and toxicity in the groundwater. All three alternatives should be acceptable to the public and regulatory agencies because they are protective of human health and the environment and reduce groundwater contamination; however, none of the three alternatives addresses soil contamination. Implementation of Alternative 1, or any of the three alternatives will require land and groundwater use controls to be enforced. Groundwater monitoring would be required for the respective projected cleanup periods.

The 10-year remediation time for Alternative 1 is considered to be conservative because the plume is likely to be stable and because many of the contaminant concentrations are only slightly above MCLs. Uncertainties about the nature and location of the contaminant sources means that site conditions could change during the LTM period, and that additional contaminant mass could unexpectedly enter groundwater. However, this potential drawback would apply to all alternatives and would require reevaluation in all cases. The proposed LTM period is consistent with federal recommendations that proposed or implemented remedial activities at a site should not exceed 30 years in duration (USEPA, 1988), and even if site conditions require a change in the remedial strategy it is unlikely that this time limit would be exceeded.

The final evaluation criterion used to compare each of the remedial alternatives was cost; the additional costs of Alternatives 2 and 3 do not justify the slightly reduced risk resulting from plume containment. Future exposure to potential receptors at the site will be minimized by land use restrictions and by the low contaminant concentrations. Access

to the Base (and hence the site) is controlled by Base security. Alternative 1 will reduce the level of contamination and maintain the necessary degree of protection to potential receptors at or downgradient from the site, and is the recommended remedial alternative for shallow groundwater at LF-06. A LTM plan for groundwater, including a generic SAP, is provided in Section 7.

SECTION 7

LONG-TERM MONITORING PLAN

7.1 OVERVIEW

In keeping with the requirements of the recommended remedial alternative for LF-06 at Columbus AFB (RNA with institutional controls and LTM), a long-term groundwater monitoring plan has been developed. The purpose of this component of the suggested remedial alternative for the site is to assess site conditions over time, confirm the effectiveness of natural processes at reducing contaminant mass and minimizing dissolved contaminant migration, assess compliance with regulatory cleanup goals, and evaluate the need for additional remediation.

The LTM plan consists of identifying the location of two separate groundwater monitoring networks and developing a groundwater sampling and analysis strategy to demonstrate attainment of site-specific remediation goals and to verify the predictions of the model developed for LF-06. The strategy described in this section is designed to monitor dissolved contaminant migration over time and to verify that RNA is occurring at rates sufficient to protect potential receptors. In the event that data collected under this LTM program indicate that natural processes are insufficient to protect human health and the environment, contingency controls to augment the beneficial effects of RNA would be necessary.

7.2 MONITORING NETWORKS

Two separate sets of wells will be utilized at the site as part of the LTM component of the remedial alternative. The first set will consist of ten LTM wells located in, upgradient from, and downgradient from the observed contaminant plume to verify that natural

attenuation is occurring at rates sufficient to minimize plume expansion and reduce both dissolved benzene and chlorinated solvent concentrations. This network of wells will consist of monitoring wells screened across the water table (shallow wells) to provide short-term confirmation of the effectiveness of natural attenuation. The second set of wells will consist of four sentry wells: two at locations along a line perpendicular to the general direction of groundwater flow, approximately 1,500 feet west of monitoring points MPL and MPI, and the other two between the site and the southern base boundary. The purpose of the sentry wells is to verify that no benzene, chlorobenzene, TCE, or vinyl chloride concentrations migrate beyond the area under institutional control. Conservative model results suggest that the none of the contaminants of concern should reach the sentry wells at concentrations exceeding state criteria. The proposed LTM and sentry well locations are presented on Figure 7.1

7.2.1 Long-Term Monitoring Wells

At ten locations, groundwater wells within, upgradient from, and downgradient from the current BTEX plume will be used to monitor the effectiveness of RNA in reducing total contaminant mass and minimizing contaminant migration at LF-06. Of the ten wells proposed for the LTM network, six (W-18, W-19, W-20, W-21, W-22, and W-81) were installed during previous investigations. The remaining four wells would be installed upon implementation of this plan. Figure 7.1 identifies the proposed locations for wells to be used for LTM. This well network will supplement the four proposed sentry wells (see Section 7.2.2) to provide evidence of continuing RNA and to allow additional response time if site conditions change.

Existing well W-19 is proposed for monitoring the background groundwater quality in the shallow portion of the surficial aquifer. In addition, existing well W-20 is proposed to monitor background groundwater quality in the southern portion of the site. Monitoring wells are proposed to replace monitoring points MPF(s) and MPD(s) to monitor the shallow groundwater at the largest suspected source area and immediately downgradient

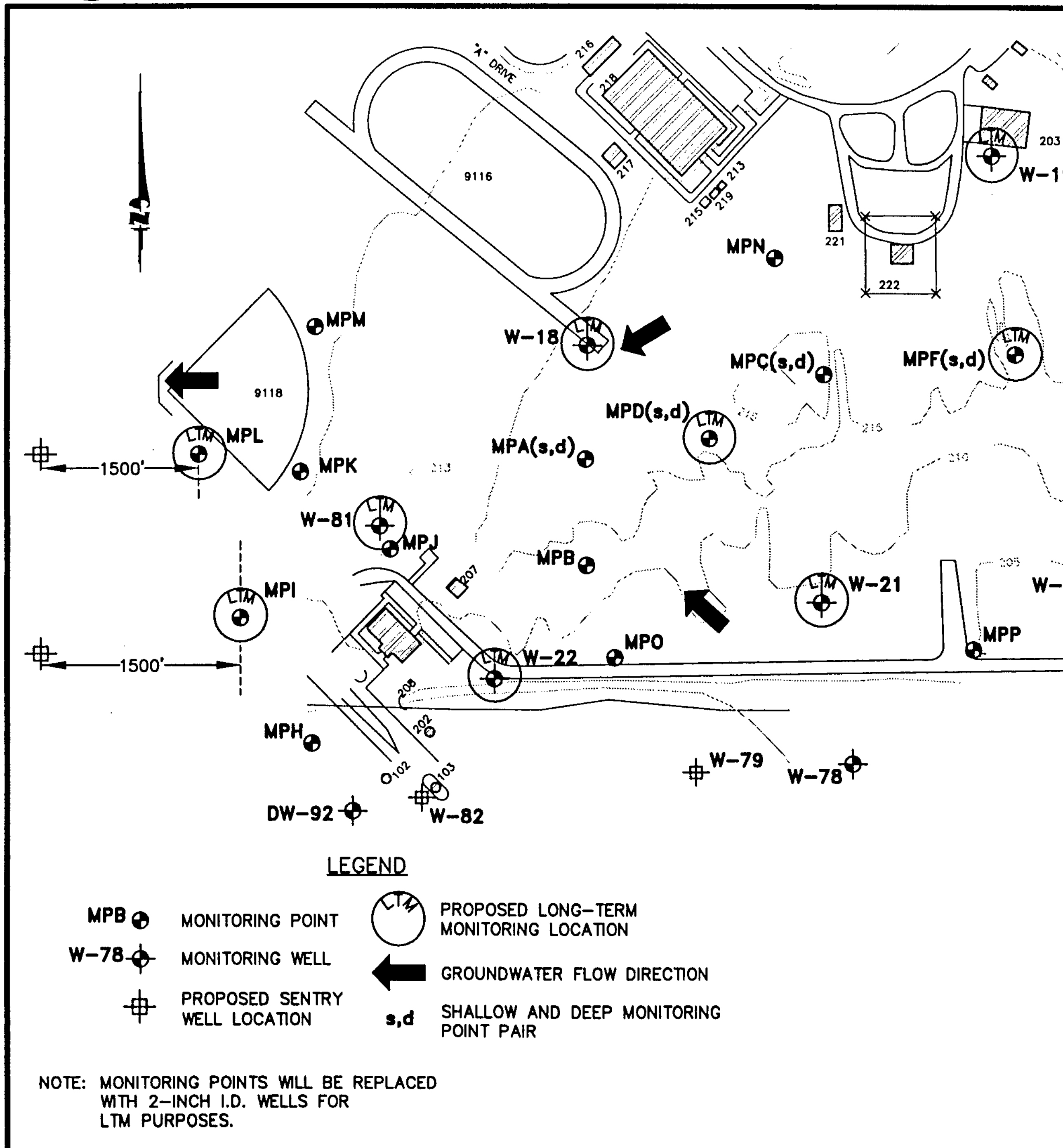

FIGURE 7.1

PROPOSED LONG-TERM MONITORING AND SENTRY WELL LOCATIONS

Site LF-06 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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from this source area along the centerline of the contaminant plume, respectively. The two existing monitoring wells W-18 and W-21 are included in the LTM plan because both wells also are located in suspected source areas for groundwater contamination. Typically, downgradient wells are installed within both the anaerobic and aerobic treatment zones; however, because the aerobic treatment zone is difficult to define, monitoring will occur at the downgradient wells with observed contaminant concentrations that exceed state criteria. Therefore, existing monitoring wells W-22 and W-81 are proposed to be monitored along with a pair of wells that will replace monitoring points MPL and MPI. The remaining existing wells (W-20, W-78, and DW-92) would not be used for LTM because they are not in the direct flow path downgradient from the any of the suspected source areas.

The four new LTM monitoring wells will have 10-foot screened intervals. Shallow wells will be screened across the water table with approximately 8 feet of the 10-foot screen positioned below the water table. However, during the installation of new LTM wells it would be necessary to screen wells across the actual water table (15 to 20 feet bgs) rather than the perched water table [observed at monitoring point MPF(s) and MPD(s)]. Sampling frequency and analytical parameters to be monitored are discussed in Section 7.3.

7.2.2 Sentry Wells

Four sentry monitoring wells are proposed for monitoring at the site (Figure 7.1). Two are recommended for installation approximately 1,500 feet (i.e., two years of travel time at the estimated average groundwater velocity) downgradient from the current leading edge of the contaminant plume. The sentry wells are more than 2,500 feet from the western Base boundary. These locations, however, should be considered tentative because of numerous roads and underground utility corridors. The other two sentry locations will use existing wells W-82 and W-79. These locations have been selected to confirm that the direction of plume migration does not shift toward the base boundary. It is recommended that the sentry well locations be finalized upon implementation of this plan.

The purpose of sentry wells is to verify that no contaminated groundwater exceeding state criteria migrates beyond the area under institutional control. Although model results strongly suggest that the contaminant plume will not migrate beyond this area at concentrations exceeding chemical-specific state MCLs (Table 6.1), these sentry wells are the technical mechanisms used to demonstrate protection of human health and the environment and compliance with site-specific numerical RAOs. These wells will be installed and monitored to assure that the selected remedy is providing the anticipated level of risk reduction and remediation at the site. Sampling frequency and analytical parameters to be monitored are discussed in Section 7.3.

As with the LTM wells, the sentry wells will be screened in the same hydrogeologic units as the contaminant plume. Data presented in this report concerning the nature and extent of contamination at the site suggest that a 10-foot screen with approximately 8 feet of screen below the groundwater surface will be sufficient to intercept the dissolved contaminant plume in the shallow groundwater at this site.

7.3 GROUNDWATER SAMPLING

To ensure that sufficient contaminant removal is occurring at LF-06 to meet site RAOs, the long-term groundwater monitoring plan includes a sampling and analysis plan (SAP). Groundwater samples will be collected and analyzed from LTM and sentry wells to verify that natural processes are effectively reducing contaminant mass and mobility. Reductions in toxicity will be implied by mass reduction. The SAP also is aimed at assuring that RNA can achieve regulatory action levels for dissolved contaminants of concern.

7.3.1 Analytical Protocol

All LTM and sentry wells in the LTM program will be sampled and analyzed to determine compliance with chemical-specific remediation goals and to verify the effectiveness of RNA at the site. Water level measurements will be made during each sampling event. Groundwater samples from the LTM and sentry wells will be analyzed for the parameters listed in Tables 7.1 and 7.2, respectively. A site-specific groundwater SAP should be prepared prior to initiating the LTM program.

7.3.2 Sampling Frequency

Each of the 13 LTM and sentry wells will be sampled annually for 10 years. Thereafter, review meetings could be scheduled to determine future LTM frequency. For example, if LTM demonstrates the effectiveness of the proposed remedial alternative at this site, the sampling frequency could be reduced to once every two years or sampling could be eliminated. Conversely, if the data collected at any time during the monitoring period indicate the need for additional remedial activities at the site as a result of significant plume expansion or imminent pathway completion, the sampling frequency should be adjusted accordingly.

TABLE 7.1
LONG-TERM MONITORING ANALYTICAL PROTOCOL
SITE LF-06 RNA TS
COLUMBUS AFB, MISSISSIPPI

Analyte	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Ferrous Iron (Fe^{2+})	Colorimetric A3500-Fe D	Field only	Elevated ferrous iron concentrations may be indicative of the anaerobic biodegradation process of iron reduction	Annually for 10 Years	Collect 100 mL of water in a glass container; acidify with hydrochloric acid per method	Field
Ferrous Iron (Fe^{2+})	Colorimetric HACH 25140-25	Alternate method; field only	Same as above.	Annually for 10 Years	Collect 100 mL of water in a glass container	Field
Temperature	E170.1	Field only	Metabolism rates for microorganisms depend on temperature	Annually for 10 Years	N/A	Field
Dissolved Oxygen	Dissolved oxygen meter	Refer to Method A4500 for a comparable laboratory procedure	Concentrations less than 1 mg/L generally indicate an anaerobic pathway	Annually for 10 Years	Collect 300 mL of water in biochemical oxygen demand bottles; analyze immediately; alternately, measure dissolved oxygen in situ	Field
pH	E150.1/SW9040, direct reading meter	Protocols/Handbook methods[a/]	Aerobic and anaerobic processes are pH-sensitive	Annually for 10 Years	Collect 100–250 mL of water in a glass or plastic container; analyze immediately	Field
Conductivity	E120.1/SW9050, direct reading meter	Protocols/Handbook methods	General water quality parameter used as a marker to verify that site samples are obtained from the same groundwater system	Annually for 10 Years	Collect 100–250 mL of water in a glass or plastic container	Field
Nitrate (NO_3^{-1})	IC method E300 or method SW9056; colorimetric, method E353.2	Method E300 is a Handbook method; method SW9056 is an equivalent USEPA procedure	Electron acceptor for microbial respiration if oxygen is depleted	Annually for 10 Years	Collect up to 40 mL of water in a glass or plastic container; cool to 4°C; analyze within 48 hours	Fixed-base
Ammonium (NH_4^+)	Colorimetric CHEMetrics K-1510	Field only	Confirm nitrogen fixation and/or nitrate reduction	Annually for 10 Years	Collect 100–250 mL of water in a glass or plastic container; analyze immediately	Field

TABLE 7.1 (concluded)
LONG-TERM MONITORING ANALYTICAL PROTOCOL
SITE LF-06 RNA TS
COLUMBUS AFB, MISSISSIPPI

Analyte	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Sulfate (SO_4^{2-})	IC method E300 or method SW9056 or Hach SulfaVer 4 method	Method E300 is a Handbook method; method SW9056 is an equivalent procedure. Hach method is photometric	Electron acceptor for anaerobic microbial respiration	Annually for 10 Years	Collect up to 40 mL of water in a glass or plastic container; cool to 4°C	Fixed-base or field (for Hach method)
Redox potential	A2580 B	Measurements are made with electrodes; results are displayed on a meter; samples should be protected from exposure to atmospheric oxygen	The redox potential of groundwater influences and is influenced by biologically mediated reactions; the redox potential of groundwater may range from more than 200 mV to less than -400 mV	Annually for 10 Years	Collect 100–250 mL of water in a glass container, filling container from bottom; analyze immediately	Field
Methane, Ethane, and Ethene	RSKSOP-114 modified to analyze water samples for methane by headspace sampling with dual thermal conductivity and flame ionization detection.	Method published and used by the USEPA Natural Risk Management Research Laboratory	The presence of methane suggests BTEX degradation via an anaerobic pathway utilizing carbon dioxide (carbonate) as the electron acceptor (methanogenesis). The presence of ethane and ethene suggest that reductive dehalogenation of vinyl chloride is occurring.	Annually for 10 Years	Collect water samples in 40 mL volatile organic analysis (VOA) vials with butyl gray/Teflon-lined caps (zero headspace); cool to 4°C	Fixed-base
Aromatic and chlorinated hydrocarbons (BTEX, TMB isomers, and chlorinated compounds)	SW8260A	Handbook method; analysis may be extended to higher molecular weight alkylbenzenes	Method of analysis for BTEX and chlorinated solvents, which are the primary target analytes for monitoring natural attenuation; concentrations of benzene, chlorobenzene, TCE and vinyl chloride must also be measured for regulatory compliance	Annually for 10 Years	Collect water samples in a 40 mL VOA vial with zero headspace; cool to 4°C; add sulfuric acid to pH ≤ 2	Fixed-base

a/ Analytical methods from the Air Force protocol document and the AFCEE Handbook are presented by Wiedemeier *et al.* (1995).

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TABLE 7.2
POINT-OF-COMPLIANCE MONITORING ANALYTICAL PROTOCOL
SITE LF-06 RNA TS
COLUMBUS AFB, MISSISSIPPI

Analyte	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Temperature	E170.1	Field only	Well purging	Annually for 10 Years	N/A	Field
Dissolved Oxygen	Dissolved oxygen meter	Refer to method A4500 for a comparable laboratory procedure	Concentrations less than 1 mg/L generally indicate an anaerobic pathway	Annually for 10 Years	Collect 300 mL of water in biochemical oxygen demand bottles; analyze immediately; alternately, measure dissolved oxygen in situ	Field
pH	E150.1/SW9040, direct reading meter	Protocols/Handbook methods[a]	Aerobic and anaerobic processes are pH-sensitive	Annually for 10 Years	Collect 100–250 mL of water in a glass or plastic container; analyze immediately	Field
Conductivity	E120.1/SW9050, direct reading meter	Protocols/Handbook methods	General water quality parameter used as a marker to verify that site samples are obtained from the same groundwater system	Annually for 10 Years	Collect 100–250 mL of water in a glass or plastic container	Field
Aromatic and chlorinated hydrocarbons (BTEX, TMB isomers, and chlorinated compounds)	SW8260A	Handbook method; analysis may be extended to higher molecular weight alkylbenzenes	Method of analysis for BTEX and chlorinated solvents, which are the primary target analytes for monitoring natural attenuation; concentrations of benzene, chlorobenzene, TCE and vinyl chloride must also be measured for regulatory compliance	Annually for 10 Years	Collect water samples in a 40 mL VOA vial with zero headspace; cool to 4°C; add sulfuric acid to pH ≤2	Fixed-base

a/ Analytical methods from the Air Force protocol document and the AFCEE Handbook are presented by Wiedemeier *et al.* (1995).

SECTION 8

CONCLUSIONS AND RECOMMENDATIONS

This report presents the results of a TS conducted to evaluate RNA of groundwater contaminated with fuel hydrocarbons and chlorinated solvents at Site LF-06, Columbus AFB, Mississippi. Specifically, analytical models were used in conjunction with site-specific geologic, hydrologic, and laboratory analytical data to evaluate the migration and biodegradation of fuel compounds and solvents dissolved in groundwater. To obtain the data necessary for the RNA demonstration, Parsons ES collected and analyzed soil and groundwater samples from the site.

Numerous fuel hydrocarbon compounds and chlorinated solvents have been detected in site groundwater. However, only benzene, TCE, VC, and CB were present in concentrations exceeding MCLs in November 1996. Moreover, of these latter compounds, only CB was detected at a concentration greater than 23 µg/L. In the case of CB, the highest concentration (200 µg/L) was detected in a monitoring point that was screened in a perched zone of saturation immediately adjacent to a disposal trench. In a monitoring point screened in the aquifer beneath that zone, the CB concentration was well below the MCL of 100 µg/L. These relatively low concentrations suggest that the sources of contamination are limited in dimension and mass. The low concentrations also make it difficult to pinpoint source areas, except in the case of CB discussed above.

Geochemical data provided one line of evidence used to document RNA at LF-06. Comparison of BTEX, chlorinated solvent, electron acceptor, and biodegradation byproduct isopleth maps for groundwater at Site LF-06 provides strong geochemical evidence of fuel and chlorinated solvent biodegradation. Geochemical data strongly

suggest that biodegradation of fuel hydrocarbons and other organic matter (e.g., native organic matter and landfill leachate) is occurring at the site via aerobic respiration and the anaerobic processes of denitrification, iron reduction, sulfate reduction, nitrogen fixation, and methanogenesis. Evidence also strongly suggests that some of the chlorinated solvents are being used as electron acceptors as the other compounds are consumed as electron donors/substrates. This process is known as reductive dehalogenation. Rates of biodegradation were estimated from observed contaminant concentrations and the method of Buscheck and Alcantar (1995).

Historical contaminant concentration data provide a second line of evidence for RNA. Specifically, these data suggest that contaminant concentrations have remained relatively stable over time, with minor fluctuations that are likely the result of varied sampling methods and analytical methods, as well as seasonal fluctuations due to changing hydrogeologic conditions. These data also suggest that the plume is relatively stable, as concentrations at some of the wells would have changed more noticeably over time if the plume were continuing to expand.

Site-specific geologic, hydrologic, and chemical data were then used in the analytical groundwater model to simulate the effects of advection, dispersion, sorption, and biodegradation on the fate and transport of the dissolved contaminants. Site-specific data were used for model implementation. Model parameters that could not be obtained from existing site data were estimated using widely accepted literature values for aquifer materials similar to those found at the site. Conservative aquifer parameters were used to construct the model for this site. Therefore, the model results presented herein represent conservative predictions of groundwater contaminant plume fate and transport. Results of compound-specific, one-dimensional analytical models suggest that the contaminant plumes will remain stable, even if sources persist at levels that produced the highest observed concentrations for each contaminant. This complements the historical contaminant data, which also suggest that the plumes are stable.

The results of this study suggest that RNA of dissolved hydrocarbons is occurring at Site LF-06. Given that the models predict no impact to known receptors, the recommended remedial alternative for site groundwater impacted by fuel hydrocarbons and chlorinated hydrocarbons includes RNA, institutional controls, and LTM. Active source area remediation is not practical because the source areas are not well defined and probably not very large (i.e., they are low-mass sources). In addition, the low concentrations of contaminants detected in site groundwater and the apparent stabilization of the plume make it unlikely that any downgradient receptors will be impacted. Engineered groundwater remedial alternatives will not be cost-effective because a relatively small mass of contaminants will be removed for a relatively high cost.

Because the site is located on an active, secured installation, all future site activities will occur under the direct supervision of the Air Force. The estimated rates of biodegradation, when coupled with sorption, dispersion, and dilution, should be more than sufficient to reduce and maintain dissolved contaminant concentrations at levels below current regulatory standards long before potential downgradient receptors could be adversely affected. Construction activities in the plume area, and groundwater use in and downgradient from the plume area, should be restricted until groundwater contaminant concentrations decrease below state MCLs for benzene, TCE, VC, and CB.

To verify the results of the modeling effort, and to ensure that RNA is occurring at rates sufficient to protect potential downgradient receptors, groundwater from ten LTM wells should be sampled and analyzed for the parameters listed in Table 7.1. In addition, four sentry wells downgradient from the BTEX plume should be sampled for the parameters listed in Table 7.2. Figure 7.1 shows suggested locations for the LTM and sentry wells. Each of the LTM and sentry wells will be sampled annually for 10 years. After this time, the results from LTM should be evaluated to determine whether sampling will cease, will decrease in frequency, or will continue on an annual basis. If dissolved contaminant concentrations in groundwater collected from the sentry wells exceed regulatory criteria, or

if monitoring data suggest that contaminant concentrations are increasing due to an as yet unidentified source, additional evaluation or corrective action may be necessary at this site. In addition, if contaminant concentrations remain relatively stable and show no decreasing trend, additional work could be needed as well.

SECTION 9

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APPENDIX A

APPENDIX A-1

GEOLOGIC BORING LOGS

GEOLOGIC BORING LOG

BORING NO.:	LF06-MPC	CONTRACTOR:	PARSONS ES	DATE SPUD:	11/16/96
CLIENT:	AFCEE	RIG TYPE:	Geoprobe	DATE CMPL.:	11/16/96
JOB NO.:	729691	DRLG METHOD:	Geoprobe	ELEVATION:	GS
LOCATION:	COLUMBUS AFB	BORING DIA.:	2 1/8"	TEMP:	50-55-60° F
GEOLOGIST:	B. Henry	DRLG FLUID:	NA	WEATHER:	Pt. Cloudy - Breezy

COMENTS: C Snyder

Elev (ft)	Depth (ft)	Profile	USCS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID (ppm)	Ambient (ppm)	TOTAL BTEX (ppm)	TPH (ppm)
0-4 3'Rec. (75%)	1		CL/ML	0-4' CLAY & SILT - reddish brown to yellow brown, soft-firm, v silty-sandy, moist, trace gravel, no odor		0510	D		78	0.0		
4-8' 4'Rec (100%)	5		CL	4-8' SILTY CLAY - yellow brown turning brick red, soft-sl stiff, sl moist, massive, no odor			D		87	0.0		
8-12 4'Rec. (100%)	10		CL/ML	8-12 - SILTY CLAY - brick red, soft-sl stiff, massive, trace gravel chunks, sl moist, grading to orangish brown SILT at 11.5'		0530	D		94	0.0		
12-16 4'Rec. (100%)			ML/SM	12-14 - CLAYEY SILT - sandy - AA, grading to SAND (14-16') - orangish brown, vf-f gr, silty, mod sorted, loose, dense, w/ thin interbeds of clayey matrix			D		85	0.0		
16-18 2'Rec. (100%)	15		SC	16-18 SAND - orangish brown, vf-f gr, with thin 6" gravel bed at 17.5', some clay matrix, loose, v. moist to damp			D		66	0.0		
18-20 2'Rec. 100%	20			18-20 - SAND - brown to graybrown, AA, with thin interbeds of rounded gravel to 1", wet		WATER ~18'	D		95	0.0		
23-25 1.5'Rec. (75%)	25		SC	23-25' - SAND & GRAVEL - AA - saturated			D		62	0.0		
				Drive spoon to 34' → Drive like sand & gravel								
34-36' 1'Rec 50%	30, 35		SC	SAMPLE 34-36' - SAND & GRAVEL - brown, f-crs gr, w/ gravel to 1", sub angular-round, poorly sorted, loose, saturated								

TD = 36'

Screen 20-23' (Pre Pack)
31-31.5' (Implant)

NOTES

- bgs – Below Ground Surface
- GS – Ground Surface
- TOC – Top of Casing
- NS – Not Sampled
- SAA – Same As Above

SAMPLE TYPE

- D – DRIVE
- C – CORE
- G – GRAB

▼ Water level drilled

FIGURE 3.4

GEOLOGIC BORING LOG

Sites ST-24 and LF-06
Intrinsic Remediation TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

GEOLOGIC BORING LOG

BORING NO.: LF06-MPD CONTRACTOR: PARSONS ES DATE SPUD: 11/16/96
CLIENT: AFCEE RIG TYPE: Geoprobe DATE CMPL.: 11/16/96
JOB NO.: 729691 DRLG METHOD: Geoprobe ELEVATION: GS
LOCATION: COLUMBUS AFB BORING DIA.: 2 1/8" TEMP: 60-65°F
GEOLOGIST: B. Henry DRLG FLUID: NA WEATHER: Clear - Ptly Cloudy
COMENTS: C. Snyder

Elev (ft)	Depth (ft)	Profile	USCS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID (ppm)	Ambient (ppm)	TOTAL BTEX (ppm)	TPH (ppm)
0-4' 3' Rec (75%)	1		Back Fill	0-3.5' BACKFILL - CLAYEY SAND & GRAVEL - brown, v. poorly sorted, vf-crs gr w/ gravel, clay mtx, firm-hard, sl. moist			D		115	0.0		
4-8' 3' Rec 75%	5		LAND FILL	3.5-4.0 - LANDFILL TRASH - Plastic + Glass w/ mixed in clay → Hit obstruction at ~6' - Slide R; 0-3.5' - AA 3.5-4' - SILTY SAND		3-4' & Redrill	D		170	0.0		
8-11 3' Rec 100%			FILL	4-8 SILT & CLAY Backfill w/ LANDFILL TRASH - Fiber, wood, styrofoam			D(2)		95	0.0		
			CL	8-11 SILTY CLAY - gray brown, firm-v. stiff, silty, moist, massive → Water ~ 9-10'								
11-14 Rec 3' (100%)	10		CL	11-14 - SILTY CLAY - Gray, mottled red, firm-stiff, v. silty, grading to 3-4" SILTY SAND at Base, v. moist to wet			D		90	0.0		
14-16.5 2' Rec (66%)	15		CL	14-16.0' SILTY-SANDY CLAY - AA, turning reddish brown,			D		100	0.0		
16.5-18.5 1' Rec (50%)			SC/SW	16.0-16.5' - SANDY GRAVEL - vf-crs gr. gravel to 3/4", poorly sorted wet, loose			D		83	0.0		
	20			16.5-18.5' - SANDY GRAVEL - AA								
				Drive to 30'								
	25											
30-32 1' Rec (50%)				Small Sample - Sample 30-32'								
	30		SC/SW	30-32 SAND & GRAVEL - brown, vf-cr gr, gravel to 1/2", poorly sorted, loose, wet			D		106	5.0		
	35											

SET 3' PrePak Screen (1/2" dia) at 15+81 / Set 6" insert 31-31.5'

NOTES
bgs — Below Ground Surface
GS — Ground Surface
TOC — Top of Casing
NS — Not Sampled
SAA — Same As Above

1615 off Location.

SAMPLE TYPE
D — DRIVE
C — CORE
G — GRAB

Water level drilled

FIGURE 3.4

GEOLOGIC BORING LOG

Sites ST-24 and LF-06
Intrinsic Remediation TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\COLUMBUS\96DN0868, 09/26/96 at 07:57

GEOLOGIC BORING LOG

BORING NO.:	LF06-MPF	CONTRACTOR:	PARSONS ES	DATE SPUD:	11/15/96
CLIENT:	AFCEE	RIG TYPE:	Geoprobe	DATE CMPL.:	11/15/96
JOB NO.:	729691	DRLG METHOD:	Geoprobe	ELEVATION:	GS
LOCATION:	COLUMBUS AFB	BORING DIA.:	2 1/8"	TEMP:	60-65°F
GEOLOGIST:	B. Henry	DRLG FLUID:	NA	WEATHER:	Clear
COMENTS:	C. Snyder				

Elev (ft)	Depth (ft)	Profile	USCS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID (ppm)	Ambient (ppm)	TOTAL BTEX (ppm)	TPH (ppm)
0-4 2' Rec (50%)	1	CL (backfill)		0-3' CLAY - reddish brown, soft, moist, backfill material								
		LAND FILL		3-4' LANDFILL TRASH - Plastic sheeting w/ black decomposed organic matter	1	3-4" 1250	D		75	0.0		
4-8' 1' Rec (25%)	5	FILL		4-8 LANDFILL TRASH - black-gray, decomposed organic matter w/ some clay material, wet		Water ~ 3-4'			210	0.0		
8-10.5' 2.5' (100%)	10	CL		8-9 - CLAY - reddish brown, mottled gray, soft - stiff, v. silty, moist					320	0.0		
10-12 2' Rec 100%		SC		9-10 CLAYEY SAND & GRAVEL, reddish brown/orange - firm, v. poorly sorted, moist - wet, slight odor 10-11 - AA					75	0.0		
	15								79	0/0		
		SC		11-12' SAND - orangish brown, f-m gr, well sorted, silty, unpoor loose, dense, wet		NOTE: WATER IN SAMPLER HAS SHEEN ON IT			35	0.0		
	20	SP		12-14' - SAND - brown, gray brown, f gr, well sorted, some clay mtx, loose, dense, v. moist, but not wet, hydrocarbon odor, Gravel at base 2" SWITCH TO SMALL SAMPLER					71			
18-20 1.5' Rec 75%	25	SC		18-20' SAND - reddish brown, loose, f-m gr, mod sorted, w/ layers of poorly sorted gravel, wet, no odor								
26-28' 1.25' Rec (69%)		SC		26-28' - SAND & GRAVEL - WET					NR			
33-34.5 0.5' Rec (33%)	30	SC/SW		33-34.5' SAND & GRAVEL - orangish brown, vf - crs gr, gravel to 1", poorly sorted, silty clayey, loose, saturated			1530		NR			
	35											

Couldn't go beyond 35' - did not encounter confining layer. → Set 3' of Screen from 11-14' / Set 6" Insert at 30.5-31'

NOTES

bgs - Below Ground Surface
GS - Ground Surface
TOC - Top of Casing
NS - Not Sampled
SAA - Same As Above

SAMPLE TYPE

D - DRIVE
C - CORE
G - GRAB

▼ Water level drilled

FIGURE 3.4

GEOLOGIC BORING LOG

Sites ST-24 and LF-06
Intrinsic Remediation TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\COLUMBUS\96DN0868, 09/26/96 at 07:57

GEOLOGIC BORING LOG

Sheet 1 of 1

BORING NO.: LF06-MPG CONTRACTOR: Parsons ES DATE SPUD: 11/13/96
CLIENT: AFCEE RIG TYPE: Geoprobe DATE CMPL.: 11/13/96
JOB NO.: 729691 DRLG METHOD: " ELEVATION: GS
LOCATION: COLUMBUS AFB BORING DIA.: 2 1/4" TEMP: 50°F
GEOLOGIST: B. Henry DRLG FLUID: NA WEATHER: Cloudy
COMENTS: C. Snyder

Elev (ft)	Depth (ft)	Profile	USCS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID (ppm)	TLV (ppm)	TOTAL BTEX (ppm)	TPH (ppm)
0-4' 1.0'Rec (25%)	1	0-4' 0755	SW	Gravelly SAND - f-crs grained, gravel to 1.5", poorly sorted, moist, silt-clay matrix, orange-brown, mod. dense, no stain or odor.	1	0-4'	D		21.2 / 0.0			
4-8' 2½'Rec. 60%	5	4-8 0755	SP/SM	SILTY SAND - gray, interbedded w/ red, silty-clayey matrix, mod. well sorted, dense, moist, no stain or odor, → samplers packed off. Drive 2' sampler to 9.5' - sample	2	4-8'	D		34.7 / 0.0			
10-12 (75%)	10	10-12 0817	CL	10-12' SILTY CLAY - orangish brown, mottled gray, silty, very stiff, mod. plastic, dense, moist, no stain or odor			D	10-12	52.0	0.0		
14-16 (80%)	15	14-16 0840	CL / SP	14-15' SILTY CLAY - reddish brn, very stiff, moist, NSO. 15-16' SILTY SAND - light gray, very fine grained, well sorted, loose-friable, very moist, dense, NSO		Water @ 11-12'	D	14-16	44.6	0.0		
16-18 75%	20	16-18 0900	SP/SM	16-18' SAND - 6" light gray, AA, becoming reddish brown, very fine to fine grained, mod. well sorted, friable-loose, w/ bottom 3" poorly sorted w/ gravel to 1/2". Saturated.			D	16-18	52.0	0.0		
	25											
	30			T.D @ 18', Drove 2½" Rod to TD, set well Screen @ 15-18' (3/4" Pre-Pak PVC) w/ 20' Riser → Cut back to 15'								
	35											

/10:15 - Done/

NOTES
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SAA – Same As Above

SAMPLE TYPE
D – DRIVE
C – CORE
G – GRAB

Water level drilled

FIGURE 3.4

GEOLOGIC BORING LOG

Sites ST-24 and LF-06
Intrinsic Remediation TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

GEOLOGIC BORING LOG

BORING NO.: LF06-MPH
CONTRACTOR: Parsons ES
DATE SPUD: 11/13/96
CLIENT: AFCEE
RIG TYPE: Geoprobe
DATE CMPL.: 11/13/96
JOB NO.: 729691
DRLG METHOD: Geoprobe
ELEVATION: GS
LOCATION: COLUMBUS AFB
BORING DIA.: 2¼"
TEMP: 55-60°F
GEOLOGIST: B. Henry
DRLG FLUID: NA
WEATHER: Cloudy, Cool
COMENTS: G. Snyder

Elev (ft)	Depth (ft)	Profile	USCS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID (ppm)	BKGD TLV (ppm)	TOTAL BTEX (ppm)	TPH (ppm)
75% Rec. (3')	1		TS CL	0-4' – 1-foot Topsoil, w/ Rest of Sample SILTY CLAY- orangish brown, firm-mod stiff, silty, sl-moist, no odor		0-4' 1600	C		15.7	0.0		
100% (4')	5		CL	4-6 – SILTY CLAY - gray, very firm-hard, stiff, sl moist, dense		4-6 1610	C		23.8	0.0		
8-10½			CL/SC	6-8' Gravelly CLAY & SILT - gray, mottled orange, silty-sandy, sl moist, firm-hard, with gravel to 1/4", very poorly sorted, dense		6-8	C		41.4	0.0		
100% (2.5')	10					8-10½ 1622	C		54.0	0.0		
10½-12½			SC	8-10.5' SAND - reddish to orangish brown, silty-clayey, f-vf grained, trace gravel to 1/4", loose, dense, very moist, no odor, at base		10.5-12.5	C		46.0	0.0		
75% (1.5')	15			10.5 - 12.5 SAND - Orangish Brown, loose, wet, f-m gr, silty in part, mod sorted, dense, no odor								
	20			Drive 12.5 - 14.0 TD = 14.0'								
	25		1655	Set Screen 9.0 - 14.0 5' 0.5" [illegible] PVC WATER AT 10 - 10.5'								
	30			1700 - Decon + Rig Down								
	35											

NOTES
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GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE
D – DRIVE
C – CORE
G – GRAB

Water level drilled

FIGURE 3.4

GEOLOGIC BORING LOG

Sites ST-24 and LF-06
Intrinsic Remediation TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

GEOLOGIC BORING LOG

BORING NO.:	LF06-MPI	CONTRACTOR:	Parsons ES	DATE SPUD:	11/15/96
CLIENT:	AFCEE	RIG TYPE:	Geoprobe	DATE CMPL.:	11/15/96
JOB NO.:	729691	DRLG METHOD:	Geoprobe	ELEVATION:	GS
LOCATION:	COLUMBUS AFB	BORING DIA.:	2 1/8"	TEMP:	50° F
GEOLOGIST:	B. Henry	DRLG FLUID:	NA	WEATHER:	Clear & Sunny
COMENTS:	C. Snyder				

Elev (ft)	Depth (ft)	Profile	USCS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID (ppm)	Ambient (ppm)	TOTAL BTEX (ppm)	TPH (ppm)
0-4' 3' Rec (75%)	1		CL	SILTY CLAY - gray to reddish brown, soft-firm, v. silty, moist		0745	D		80	0.0		
4-8 3' Rec (75%)	5		CL	4-8' SILTY CLAY - gray, mottled orangish brown, soft-friable, stiff in part, v. silty, moist non-plastic		805	D		Bkgrd = Baggie		60-70 ppm	
									102	0.0		
8-11.5 3' Rec (80%)			CL	8-11.5 SILTY CLAY - AA			D					
11.5-14 2' Rec (80%)	10		CL	11.5-14 - SILTY CLAY - gray, mottled orangish brown, soft-firm, v. stiff in part, moist, v. silty, no odor		819	D		85	0.0		
									82	0.0		
14-17' 3' Rec (100%)	15			14-17' - SILTY CLAY - AA, becoming v. sandy at 16-17'		0845	D		89	0.0		
17-19.5 2' Rec			CL/SM	17-19.5' Interbedded SILTY CLAY - AA, w/ SILT - orangish brown, silt-vf gr w/ some clay matrix, soft, v. moist to wet								
	20				WATER ~20'				57	0.0		
19.5-22.5 3' Rec (100%)			SP/SC	19.5-21.5 - SAND - orangish brown, vf-f grained, silty, well sorted, some clay mtx, loose, dense, wet, no odor, grading to gravelly SAND at 21.5-22.5 - w/ gravel to 1/2"		0928			40	0.0		
	25		SP/SC						26	0.0		
				Drove ahead w/ small sampler to 25' SAMPLE 25-27								
	30		CL	25-27' SAND - orangish brown, vf-f gr, silty, loose, dense, mod sorted, wet, w/ sme Clay - reddish interbeds								
				28' → TOP CONFINING ZONE								
				29-29.5 - CLAY - weathered, gray w/ reddish oxidation,								
	35			29.5-31 - CLAY - dark gray, firm-hard, blocky								

1130 Set Screen 3' Prepak 23-26'

NOTES

bgs — Below Ground Surface
GS — Ground Surface
TOC — Top of Casing
NS — Not Sampled
SAA — Same As Above

SAMPLE TYPE

D — DRIVE
C — CORE
G — GRAB

▼ Water level drilled

FIGURE 3.4

GEOLOGIC BORING LOG

Sites ST-24 and LF-06
Intrinsic Remediation TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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GEOLOGIC BORING LOG

Sheet 1 of 1

BORING NO.:	MP-J (LF6)	CONTRACTOR:	Parsons ES	DATE SPUD:	11/8/96
CLIENT:	AFCEE	RIG TYPE:	Geoprobe	DATE CMPL.:	11/8/96
JOB NO.:	729691	DRLG METHOD:	Geoprobe	ELEVATION:	200
LOCATION:	COLUMBUS AFB	BORING DIA.:	1 3/4"	TEMP:	60°
GEOLOGIST:	RDN	DRLG FLUID:	—	WEATHER:	breezy, sunny
COMENTS:					

Elev (ft)	Depth (ft)	Profile	USCS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID (ppm)	TLV (ppm)	TOTAL BTEX (ppm)	TPH (ppm)
100	1			0-2 Brown sandy SILT		2			12			
88%				2-6.5 Brown + Orange silty SAND		4			33			
~~75%~~	5			6.5-11.5 Brown, orange, and gray, very clayey SAND		6			40			
75%			SC			8			25			
60%	10		SM	11.5-12 Red orange silty SAND		10			0			
60%						12			10			
95%			SW/SC	12-13.5 Orange-brown gravel w/silty sand		14			8.0			
80%	15			13.5-14.0 Yellow-green silty SAND		16			23			
70%						18		67	43			
	20		SW/SM	14.0-18 Yellow + orange gravel w/silty SAND								
	25			Sampled TOC (16'-18')								
	30											
	35											

NOTES

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GS — Ground Surface
TOC — Top of Casing
NS — Not Sampled
SAA — Same As Above

SAMPLE TYPE

D — DRIVE
C — CORE
G — GRAB

▼ Water level drilled

FIGURE 3.4

GEOLOGIC BORING LOG

Sites ST-24 and LF-06
Intrinsic Remediation TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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GEOLOGIC BORING LOG

BORING NO.: LF06-MPK CONTRACTOR: PARSONS ES DATE SPUD: 11/14/96
CLIENT: AFCEE RIG TYPE: Geoprobe DATE CMPL.: 11/14/96
JOB NO.: 729691 DRLG METHOD: Geoprobe ELEVATION: GS
LOCATION: COLUMBUS AFB BORING DIA.: 2 1/4" TEMP: Clear-Ptly Cloudy
GEOLOGIST: B. Henry DRLG FLUID: NA WEATHER: 60°F
COMENTS: G. Snyder

Elev (ft)	Depth (ft)	Pro-file	USCS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID (ppm)	Ambient	TOTAL BTEX (ppm)	TPH (ppm)
0-3.5 2' Rec (55%)	1		CL	0-3.5 SILTY CLAY - Red-brown, Firm, very silty-sandy, moist, no odor		0950	D		87.0	0.0		
3.5-6.5 2 1/2 Rec (83%)			CL	3.5-6.0' - Red Silty CLAY - AA								
	5		SW	6.0-6.5' - SAND GRAVEL - reddish brown, vf-m gr, w/ gravel to 1", silty-clayey matrix, loose, mod dense, moist, poorly sorted		1000	D		66	0.0		
6.5-9.0 2' Rec. (55%)									120	0.0	(SAT in SW)	
	10		SC/SW	6.5-9.0' GRAVELLY SAND - reddish brown, very fine-fine grained, w/ gravel to 1" (LS), silt & CLAY Matrix, loose, dense, moist, very poorly sorted					-			
9-11 2' Rec. (100%)									45	0.0		
11-13 2.0' Rec (100%)									142	0.0		
13-15 1.0' Rec (50%)	15		SC	9.0-11.0 SAND - orangish to reddish brown, very f-f grained, some gravel to 1", silt & clay mtx, thin 6" layers of Clayey SAND, loose, dense, moist		1037			95	0.0		
16-18 1' Rec. (50%)									113	0.0		
	20		SC / CL	11.0-13.0 SAND - AA - inc. m-crs grained, orangish brown, moist, w/ thin interbeds (6") of silty reddish brown CLAY								
	25		SC	13-15' SAND - Orangish brown, f-crs gv, w/ gravel to 1/2", poorly sorted, some silt-clay mtx, loose, mod dense, wet at base. WATER N 13 1/2'								
	30		SC/SW	16-18 SANDY GRAVEL - orangish brown, AA, Wet.		1114						
	35											

Background Empty Baggy ≈ 100 ppm Background

1120 Set 3' of Pre Pack Screen - (1 1/2" PVC-10 slot) at 15-18'

1145 DONE MPK

NOTES
bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE
D – DRIVE
C – CORE
G – GRAB

▼ Water level drilled

FIGURE 3.4

GEOLOGIC BORING LOG

Sites ST-24 and LF-06
Intrinsic Remediation TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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GEOLOGIC BORING LOG

BORING NO.: LF06-MPL CONTRACTOR: Parsons ES DATE SPUD: 11/14/96 - 0700
CLIENT: AFCEE RIG TYPE: Geoprobe DATE CMPL.: 11/14/96 - 0930
JOB NO.: 729691 DRLG METHOD: Geoprobe ELEVATION: GS
LOCATION: COLUMBUS AFB BORING DIA.: 2 1/4" TEMP: Clear - Pt. Cloudy
GEOLOGIST: B. Henry DRLG FLUID: NA WEATHER: 50-60° F
COMENTS: G. Snyder

Elev (ft)	Depth (ft)	Profile	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID (ppm)	Ambient (ppm)	TOTAL BTEX (ppm)	TPH (ppm)
0-4' 2.5' Rec. (63%)	1		SW	0-4' - SAND + GRAVEL - Red-brown, vf-crs gr w/ gravel to 1/4", silty, clayey at top, med dense, loose, sl. moist			D	0720	46.5	0.0		
4-7 3' Rec (75%)	5		SW	4-7' SAND + GRAVEL - inc. gravel to 1/2" AA			D	0723	56.5	0.0		
7-9 2' Rec (100%)			SW	7-9' SAND + GRAVEL - Reddish brown, f-crs grained w/ gravel to 1", loose, poorly sorted, angular, sl. moist, no odor			D	0750	59	0.0		
9-11 2' Rec. (100%)	10			9-11 SAND + GRAVEL - AA - becoming very moist, no odor			D	0805	69	0.0		
11-13 2' Rec. (100%)			SW	11-13' - SAND + GRAVEL - Orangish to reddish brown, f-crs gr w/ gravel to 1", very poorly sorted, silty layers w/ clay matrix, angular, loose, bottom 6" saturated, water at 12.5'			D	0815	61	0.0		
15-17 3" Rec. (12%)	15		SW	Drove small rod to 15', Sample 15-17'			D	0900	NR	NR		
	20			15-17 SAND + GRAVEL - AA (SATURATED)								
	25			TD at 17' bgs								
	30			- Tried to set 3' Pre Pak Screen, well flowed a sand packed screen in pipe, Reset 5' of 0.5" PVC 10 slot at 12-17' bgs.								
	35											

NOTES
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- SAA - Same As Above

SAMPLE TYPE
- D - DRIVE
- C - CORE
- G - GRAB

▼ Water level drilled

FIGURE 3.4

GEOLOGIC BORING LOG

Sites ST-24 and LF-06
Intrinsic Remediation TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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GEOLOGIC BORING LOG

BORING NO.:	LF06 - MPN	CONTRACTOR:	PARSONS ES	DATE SPUD:	11/16/96
CLIENT:	AFCEE	RIG TYPE:	Geoprobe	DATE CMPL.:	11/16/96
JOB NO.:	729691	DRLG METHOD:	Geoprobe	ELEVATION:	G.S.
LOCATION:	COLUMBUS AFB	BORING DIA.:	2 1/8"	TEMP:	40 - 50°F
GEOLOGIST:	B. Henry	DRLG FLUID:	NA	WEATHER:	Clear & Calm
COMENTS:	C. Snyder				

Elev (ft)	Depth (ft)	Pro-file	USCS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	Ambient	TOTAL BTEX(ppm)	TPH (ppm)
0-4 3' Rec. 75%	1		CL	0-4 SILTY CLAY - brown, reddish brown, v. silty, soft - firm, stiff in part moist		0635	C		89	0.0		
4-7.5 3.5' Rec 100%	5		CL	4-7.5 SILTY TO SANDY CLAY - brick red, soft, sl moist, friable, w/ trace L.S fragments to 1/4"			C		69	0.0		
7.5-11.5 3.5' Rec. (88%)			CL/ML	7.5-10.5 - SILTY TO SANDY CLAY - brick red - AA - incr sandy								
	10		SM	10.5 - 11.5 SILTY SAND - orangish brown, vf - f gr, silty, mod sorted, soft - loose, sl moist, no odor			D		83	0.0		
11.5-15.5 3' Rec. 75%			SM	11.5-15.5 SILTY SAND - orangish to reddish brown, vf grained, silty, sme clay mtx, v. loose, mod sorted, clean - no odor			D		77	0.0		
15.5-19 3.5' Rec. (100%)	15			15.5-18.5' SILTY SAND - AA								
			SC	18.5-19.0' Gravelly SAND - orangish brown, vf - f gr, w/ gravel to 1/2", poorly sorted, loose, damp, dense, no odor			D		80	0.0		
19-21' 2' Rec. (100%)	20		SW	19.0-21.0 - SANDY GRAVEL - reddish brown, f - crs gr w/ gravel to 1", v. poorly sorted, angular, loose, dense, wet at base		WATER AT	20' D		66	0.0		
23-25' 1' Rec. (50%)	25		SW	Drove small sampler - Sample 23-25' 23-25' SANDY GRAVEL - orangish brown to gray, f - crs gr w/ gravel to 1/2", poorly sorted, loose, subangular - rounded, saturated.			D		79	0.0		
		TD										
	30		0820	Drove Rod to 27' - SET 3' of PrePak 10-slot 1/2" dia PVC Screen at 24-27'								
	35		0830	OFF LOCATION								

NOTES

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GS – Ground Surface
TOC – Top of Casing
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SAA – Same As Above

SAMPLE TYPE

D – DRIVE
C – CORE
G – GRAB

Water level drilled

FIGURE 3.4

GEOLOGIC BORING LOG

Sites ST-24 and LF-06
Intrinsic Remediation TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L: \COLUMBUS\96DN0868, 09/26/96 at 07:57

GEOLOGIC BORING LOG

BORING NO.: LF06-MPO CONTRACTOR: Parsons ES DATE SPUD: 11/13/96
CLIENT: AFCEE RIG TYPE: Geoprobe DATE CMPL.: 11/13/96
JOB NO.: 729691 DRLG METHOD: Geoprobe ELEVATION: GS
LOCATION: COLUMBUS AFB BORING DIA.: 2¼" TEMP: 50°F, Calm
GEOLOGIST: B. Henry DRLG FLUID: NA WEATHER: Cloudy
COMENTS: G. Snyder

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	Ambient	TOTAL BTEX(ppm)	TPH (ppm)
90%R (3.6')	1		CL	0-4 SILTY CLAY, gray, mottled orange, silty, stiff, moist, no stain or odor		0-2	D		25.5	0.0		
									17.8	0.0		
4-7' 100%R (3')	5		CL	4-6' SILTY CLAY-AA, increasing silty, orangish brown, stiff, becoming friable, moist		2-4 (1345)	D		41.0	0.0		
									59.7	0.0		
7-10 (66%R) (2')			CL/SM	6-7' silty-sandy CLAY-H. gray; friable-firm, moist, inc silty sand, w/ silty layers no odor								
	10					4-7 (1400)	D		37.0	0.0		
			SM/SP	7-10 - SILTY-CLAYEY SAND, light gray, loose, silt-vf grained, well sorted, moist, slight odor in sandier sections, dense		7-10 1420	D		29.0	0.0		
	15											
						11-13 1433	D		32.0	0.0		
	20		SP/SM	10-11 - Silty-Sand/CLAY-AA								
			SP	11-13' SAND-orange, mottled gray, loose, vf-f grained, well sorted, wet, dense, no odor, some interbedded clayey layers					(SOIL BACKGROUND	~	20-40 ppm)	
	25											
			1500	Set Screen 9-14' 0.5" PVC → 5' of 10 slot + 2x 5' Risers								
	30											
	35											

NOTES

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GS — Ground Surface
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SAA — Same As Above

SAMPLE TYPE

D — DRIVE
C — CORE
G — GRAB

▼ Water level drilled

FIGURE 3.4

GEOLOGIC BORING LOG

Sites ST-24 and LF-06
Intrinsic Remediation TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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GEOLOGIC BORING LOG

BORING NO.: MPP(LF06) CONTRACTOR: Parsons ES DATE SPUD: 11/12/96 1115
CLIENT: AFCEE RIG TYPE: Geoprobe DATE CMPL.: 11/12/96 1230
JOB NO.: 729691 DRLG METHOD: Geoprobe ELEVATION: —
LOCATION: COLUMBUS AFB BORING DIA.: 2 1/8 TEMP: 60°
GEOLOGIST: RDN DRLG FLUID: — WEATHER: Cloudy
COMENTS:

Elev (ft)	Depth (ft)	Profile	USCS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
80%	1			0-1 Brown wet sandy SILT		2			0.0			
				1-1.2 Thin layer of crumbled asphalt.		4			0.0			
90%	5			1.2-3 Red sandy very clayey SILT w/gravel		6			0.0			
				3-4 Tan-brown, very sandy SILT		8			0.0			
100%	10					10			0.0			
				4-8 Tan ~~and Gray~~ clayey SILT marbled w/gray sandy clay (70% clayey SILT)		12			0.0			
90%	15											
				8-12 Gray very sandy clay								
	20			12-16 Orange silty sand becoming more gravelly w/depth								
	25											
	30											
	35											

NOTES

bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE

D – DRIVE
C – CORE
G – GRAB

Water level drilled

FIGURE 3.4

GEOLOGIC BORING LOG

Sites ST-24 and LF-06
Intrinsic Remediation TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

GEOLOGIC BORING LOG

BORING NO.: MPO/LF6 CONTRACTOR: Parsons ES DATE SPUD: 11/12/96 900
CLIENT: AFCEE RIG TYPE: DATE CMPL.:
JOB NO.: 729691 DRLG METHOD: Geoprobe ELEVATION: —
LOCATION: COLUMBUS AFB BORING DIA.: 2" TEMP: 50 F
GEOLOGIST: DRLG FLUID: — WEATHER: Cloudy-Breezy
COMENTS:

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
90%	1			0-2 Topsoil w/cobble		2			48			
				2-3 Gray silty sand		4			40			
100%	5			3-4 Gray silty Clay - brittle		6			38			
				4-8 Gray sandy slightly tight CLAY Becoming wet at 7'		8			31			
100%	10					10			28			
						12			35			
100%				8-15 Gray sandy clay (sand increasing w/depth to a very sandy clay at 12')		14			40			
	15					16			35			
	20			15-16 Gray slightly sandy CLAY								
	25											
	30											
	35											

NOTES
bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE
D – DRIVE
C – CORE
G – GRAB

▼ Water level drilled

FIGURE 3.4

GEOLOGIC BORING LOG

Sites ST-24 and LF-06
Intrinsic Remediation TS
Columbus AFB, Mississippi

PARSONS
ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\COLUMBUS\96DN0868, 09/26/96 at 07:57

GEOLOGIC BORING LOG

BORING NO.:	LF06-MPR	CONTRACTOR:	PARSONS ES	DATE SPUD:	11/14/96
CLIENT:	AFCEE	RIG TYPE:	Geoprobe	DATE CMPL.:	11/14/96
JOB NO.:	729691	DRLG METHOD:	Geo[illegible]	ELEVATION:	GS
LOCATION:	COLUMBUS AFB	BORING DIA.:	2 1/8"	TEMP:	60-65°F
GEOLOGIST:	B. Henry	DRLG FLUID:	NA	WEATHER:	Clear - Sunny
COMENTS:	C. Snyder				

Elev (ft)	Depth (ft)	Profile	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID (ppm)	Ambient (ppm)	TOTAL BTEX (ppm)	TPH (ppm)
0-4' 3'R (75%)	1		CL	0-4' CLAY - gray, mottled red-brown, stiff to soft, silty in part, plastic, v. moist		1322	D		27	0.0		
4-7' 3'R (100%)			CL	0-7' CLAY - AA			D		20	0.0		
7-10 3'R (100%)	5			7-10' SILTY CLAY - lt. gray, mottled orange-brown, stiff-firm, very silty in part, moist			D		30.4	0.0		
			CL	10-11' SILTY CLAY - AA. becoming incr silty - sandy, v. moist								
	10		SC	11-12.5 SAND - gray - grading from f-crs gr, to gravel up to 1", v. poorly - mod. sorted, loose, silty, some clay mtx, v. moist-wet		WATER ~11'	D		29.0	0.0		
							D		10.0	0.0		
	15		SC	12.5-14 - SAND. gray, f-crs grained, mod sorted, trace clay & silt matrix, wet, loose, no odor								
	20			SET 3' PrePack 1/2" PVC 10-slot Screen at 13-16								
	25											
	30											
	35											

NOTES

bgs — Below Ground Surface
GS — Ground Surface
TOC — Top of Casing
NS — Not Sampled
SAA — Same As Above

SAMPLE TYPE

D — DRIVE
C — CORE
G — GRAB

Water level drilled

FIGURE 3.4

GEOLOGIC BORING LOG

Sites ST-24 and LF-06
Intrinsic Remediation TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\COLUMBUS\96DN0868, 09/26/96 at 07:57

APPENDIX A-2

MONITORING POINT DEVELOPMENT FORMS

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB/LF6
Well Number MP A (S)

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/17, 1996
Measurement Datum TOC

Pre-Development Information

Time (Start): 237

Water Level: 3.1

Total Depth of Well: 13.7

Water Characteristics

Color Black Clear Cloudy
Odor: None Weak Moderate Strong Pickle
Any Films or Immiscible Material —
pH 690 Temperature(°C) 20.2
Specific Conductance(µS/cm) 805
Disolved Oxygen (mg/L) 0.40
Redox -75

Interim Water Characteristics

Gallons Removed 0.75 Time 254

pH 6.89

Temperature (°C) 20.3

Specific Conductance(µS/cm) 832

Disolved Oxygen (mg/L) 0.11
Redox -84

Post-Development Information

Time (Finish): 3:30

Water Level:

Total Depth of Well:

Approximate Volume Removed:

Water Characteristics

Color Clear Slight Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material
pH 6.77 Temperature(°C) 20.3
Specific Conductance(µS/cm) 824
Disolved Oxygen (mg/L) 0.62

Comments: Redox -103

13.7
3.1
10.6/10 = 1.06 gallons

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, LF6
Well Number LF6-MPA(D)

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/17, 1996
Measurement Datum —

Pre-Development Information

Time (Start): 335

Water Level: assume 3' from adjacent shallow for development purposes
Total Depth of Well: ~30'

Water Characteristics

Time 347

Color Brown
Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 5. Temperature(°C) 20.9
Specific Conductance(µS/cm) 198
Disolved Oxygen (mg/L) 0.29
Redox -290

Interim Water Characteristics

Gallons Removed 0.4

Time 406
water clear

pH 5.77

Temperature (°C) 20.9

Specific Conductance(µS/cm) 158

Disolved Oxygen (mg/L) 0.36

Redox -280

Post-Development Information

Time (Finish): 438

Water Level:

Total Depth of Well:

Approximate Volume Removed: 1 gallon

Water Characteristics

Color
Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 5.67 Temperature(°C) 20.1
Specific Conductance(µS/cm) 118
Disolved Oxygen (mg/L) 0.96

Comments: Redox

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67.5
4 | 27
24
30

30
-3
27/40 = 0.67 gallons

30
-3
27 Feet
40
=
~~27 gallons~~

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, LF6
Well Number LF6-MPB

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/17, 1996
Measurement Datum TOC

Pre-Development Information

Time (Start): 150

Water Level: 9.4

Total Depth of Well: 11.4

Water Characteristics

Color Dark brown Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 5.00 Temperature(°C) 19.8
Specific Conductance(μS/cm) 491
Disolved Oxygen (mg/L) 1.24
Redox 0.5

Interim Water Characteristics

Allow to recharge 1:57 -

Gallons Removed

pH

Temperature (°C)

Specific Conductance(μS/cm)

Disolved Oxygen (mg/L)

Redox

Post-Development Information

Time (Finish):

Water Level:

Total Depth of Well:

Approximate Volume Removed:

Water Characteristics

Color Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material
pH Temperature(°C)
Specific Conductance(μS/cm)
Disolved Oxygen (mg/L)

Comments: Redox

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, LF6
Well Number LF6-MPC(S)

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/17, 1996
Measurement Datum TOC

Pre-Development Information

Time (Start): 754

Water Level: 19.8

Total Depth of Well: 22.2

Water Characteristics

Color Brown Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 7.22 Temperature(°C) 17.4
Specific Conductance(μS/cm) 545
Disolved Oxygen (mg/L) 2.55
Redox -64

Interim Water Characteristics

Gallons Removed 0.3 Time 810

pH 6.63

Temperature (°C) 17.3

Specific Conductance(μS/cm) 512

Disolved Oxygen (mg/L) 2.56

Redox -66

Post-Development Information

Time (Finish): 840

Water Level:

Total Depth of Well:

Approximate Volume Removed: 0.5

Water Characteristics

Color Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 6.48 Temperature(°C) 17.1
Specific Conductance(μS/cm) 491
Disolved Oxygen (mg/L) 1.94

Comments: Redox -44

22.2
- 19.8
2.4 /10 = 0.24 gallons

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MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, LF6
Well Number MPCFD

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/17, 1996
Measurement Datum

Pre-Development Information

Time (Start): 915

Water Level: ~20

Total Depth of Well:

Water Characteristics

Color Brown Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 7.16 Temperature(°C) 16.3
Specific Conductance(µS/cm) 260
Disolved Oxygen (mg/L) 1.77
Redox 60

Interim Water Characteristics

Gallons Removed 1 Time 9:35

pH 5.22

Temperature (°C) 17.6

Specific Conductance(µS/cm) 184

Disolved Oxygen (mg/L) 0.42
Redox -173

Post-Development Information

Time (Finish): 1011

Water Level:

Total Depth of Well:

Approximate Volume Removed: 2g

Water Characteristics

Color Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 5.39 Temperature(°C) 17.8
Specific Conductance(µS/cm) 177
Disolved Oxygen (mg/L) 0.63

Comments: Redox -300

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MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, ST24
Well Number LF06 - MPD(S)

Job Name: AFCEE-RNA
by RN/JH/CS/BL BMH Date: 11/17, 1996
Measurement Datum Top uncut PVC

Pre-Development Information

Time (Start): 1420

Water Level: 13.0

Total Depth of Well: 15.77

TOP UNCUT PVC PIPE

Water Characteristics

Color Brown Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material None
pH NR Temperature(°C) NR
Specific Conductance(µS/cm) NR
Disolved Oxygen (mg/L) NR

Interim Water Characteristics

Well purged dry immediately, never recovered (waited 20 min.)

Gallons Removed

pH

NOT SAMPLED

Temperature (°C)

Specific Conductance(µS/cm)

Disolved Oxygen (mg/L)

Post-Development Information

Time (Finish):

Water Level:

Total Depth of Well:

Approximate Volume Removed:

Water Characteristics

Color Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material
pH Temperature(°C)
Specific Conductance(µS/cm)
Disolved Oxygen (mg/L)

Comments:

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MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, ST24
Well Number LF06 - MPD(D)

Job Name: AFCEE-RNA
by RN/JH/CS/BL BMH Date: 11/17, 1996
Measurement Datum NA

Pre-Development Information

Time (Start): 1340

Water Level: NA

Total Depth of Well: ~31.5' as installed

Water Characteristics

Color Brown Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material None
pH ________ Temperature(°C) ________
Specific Conductance(μS/cm) ________
Disolved Oxygen (mg/L) ________

Interim Water Characteristics

Time	1342	1348	1352	1358
Gallons Removed	0.1	0.5	1.0	2.0
pH	5.12	5.11	5.09	5.05
Temperature (°C)	18.0	18.0	18.0	18.0
Specific Conductance(μS/cm)	180	165	150	140
Disolved Oxygen (mg/L)	0.52	0.34	0.26	0.18
Redox (mv)	89	87.5	88.9	92.6

Post-Development Information

Time (Finish): 1358

Water Level: NA

Total Depth of Well: ~31.5'

Approximate Volume Removed: 2.0+ gal.

Water Characteristics

Color Sl. Cloudy Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material None
pH 5.05 Temperature(°C) 18.0°C
Specific Conductance(μS/cm) 140
Disolved Oxygen (mg/L) 0.17

Comments:

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18.0
15.77

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, ST24
Well Number LF06 - MPF (S)

Job Name: AFCEE-RNA
by RN/JH/CS/BL BMH Date: 11/18, 1996
Measurement Datum Top PVC

Pre-Development Information

Time (Start): 0850

Water Level: 2.48' TPVC

Total Depth of Well: 12.9' TPVC

Water Characteristics

Color brown Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material None
pH 6.20 Temperature(°C) 17.9
Specific Conductance(μS/cm) 800
Disolved Oxygen (mg/L) 0.40

Interim Water Characteristics

Time	0900	0908	0915
Gallons Removed	1.0	2.0	3.0
pH	6.19	6.21	6.24
Temperature (°C)	17.8	17.6	17.6
Specific Conductance(μS/cm)	810	790	800
Disolved Oxygen (mg/L)	0.35	0.35	0.34
	-115.6	-104.3	-107.3

Post-Development Information

Time (Finish): 0915

Water Level: NR

Total Depth of Well: 12.9'

Approximate Volume Removed: 3.0 gallons

Water Characteristics

Color Tinted yel-brn Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material None
pH 6.24 Temperature(°C) 17.6
Specific Conductance(μS/cm) 800
Disolved Oxygen (mg/L) 0.34

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020 Job Name: AFCEE-RNA
Location Columbus AFB, ST24 by ~~RN/JH/CS/BL~~ BMH Date: 11/17, 1996
Well Number LF06 · MPF-D Measurement Datum NA

Pre-Development Information Time (Start): 1610

Water Level: NA Total Depth of Well: NA (~30')

Water Characteristics

Color Brown Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material None
pH 6.34 Temperature(°C) 18.7
Specific Conductance(μS/cm)
Disolved Oxygen (mg/L) 0.58

Interim Water Characteristics

Time	1625	1635	1650
Gallons Removed	0.3	0.6	1.0
pH	6.37	6.49	6.48
Temperature (°C)	18.6	18.4	18.4
Specific Conductance(μS/cm)	750	600	620
Disolved Oxygen (mg/L)	0.45	2.55*	2.11*
Redox (mv)	11.2	-13.7	-15.0

→ Sample 1650

* Sucking Air

Post-Development Information Time (Finish): 1650

Water Level: NA Total Depth of Well: NA

Approximate Volume Removed: 1.0 gal.

Water Characteristics

Color Clear w/ yellow tint Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material None
pH 6.48 Temperature(°C) 18.4 °C
Specific Conductance(μS/cm) 620
Disolved Oxygen (mg/L) 2.11

Comments:

NTS
Waters

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020 Job Name: AFCEE-RNA

Location Columbus AFB, ST24 by ~~RN/JH/CS/BL~~ BMH Date: 11/18, 1996

Well Number LF06 - MPG Measurement Datum Top PVC

Pre-Development Information Time (Start): 0700

Water Level: 14.87' TPVC Total Depth of Well: 16.9' TPVC

Water Characteristics

Color Gray Clear Cloudy

Odor: None Weak Moderate Strong

Any Films or Immiscible Material None

pH 6.59 Temperature(°C) 17.8

Specific Conductance(μS/cm) 90

Disolved Oxygen (mg/L) 7.04

Interim Water Characteristics

Gallons Removed 0.3*

pH 6.32

Temperature (°C) 17.6

Specific Conductance(μS/cm) 89

Disolved Oxygen (mg/L) 7.10

Post-Development Information Time (Finish): 0740

Water Level: NR - Bailed dry Total Depth of Well: 16.9

Approximate Volume Removed: 0.6 gal.

Water Characteristics

Color Gray Clear - Sl. Cloudy Cloudy

Odor: None Weak Moderate Strong

Any Films or Immiscible Material None

pH 6.48 Temperature(°C) 17.7

Specific Conductance(μS/cm) 110

Disolved Oxygen (mg/L) 6.90

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, LF6
Well Number LF6-MPH

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/15, 1996
Measurement Datum TOC (still sticking up)

Pre-Development Information

Time (Start): 955

Water Level: 8.85

Total Depth of Well: 14.1

Water Characteristics

Color brown Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 5.41 Temperature(°C) 18.3
Specific Conductance(µS/cm) 78
Disolved Oxygen (mg/L) 5.09
Redox 75

Interim Water Characteristics

Gallons Removed 0.5 Time=1027

allowed well to recharge from 1000 to 1022

pH 6.35

Temperature (°C) 19.1

Specific Conductance(µS/cm) 81

Disolved Oxygen (mg/L) 4.54

Redox 50

Post-Development Information

Time (Finish): 1044

Water Level:

Total Depth of Well: 14.1

Approximate Volume Removed: 1.5

Water Characteristics

Color Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 5.28 Temperature(°C) 19.9
Specific Conductance(µS/cm) 81
Disolved Oxygen (mg/L) 4.63

Comments:

$$\begin{array}{r} 14.1 \\ -8.8 \\ \hline 5.3 \end{array} \times 0.1 = 0.53 \text{ gallons to develope}$$

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location: Columbus AFB, LF6
Well Number: LF6-MP1

Job Name: AFCEE-RNA
by: RN/JH/CS/BL Date: 1996
Measurement Datum: TOC (still sticking up)

Pre-Development Information

Time (Start): 4:20

Water Level: 13.2

Total Depth of Well: 23.7'

Water Characteristics

Color: brown — Clear / Cloudy
Odor: None / Weak / Moderate / Strong
Any Films or Immiscible Material: —
pH: 5.85 Temperature(°C): 20.4
Specific Conductance(µS/cm): 287
Disolved Oxygen (mg/L): 2.07
Redox 61

Interim Water Characteristics

Gallons Removed: 0.8 gallon time 436

pH: 5.43

Temperature (°C): 20.9

Specific Conductance(µS/cm): 241

Disolved Oxygen (mg/L): 0.45

Redox 104

Post-Development Information

Time (Finish): 5:00

Water Level:

Total Depth of Well:

Approximate Volume Removed: 2.5 gallons

Water Characteristics

Color: Slightly — Clear / Cloudy
Odor: None / Weak / Moderate / Strong
Any Films or Immiscible Material: —
pH: 5.10 Temperature(°C): 20.8
Specific Conductance(µS/cm): 230
Disolved Oxygen (mg/L): 0.20

Comments: Redox 114

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MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, LF6
Well Number LF6-MPJ

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/17, 1996
Measurement Datum

Pre-Development Information

Time (Start): Pumping 1000 / Measure 1109

Water Level:

Total Depth of Well:

Water Characteristics

Color brown-orange Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 6.45 Temperature(°C) 17.7
Specific Conductance(μS/cm) 203
Disolved Oxygen (mg/L) 3.46
Redox

Interim Water Characteristics

1156

Gallons Removed 1 Liter

pH 5.97

Temperature (°C) 18.8

Specific Conductance(μS/cm) 160

Disolved Oxygen (mg/L) 5.37

Redox -5

Post-Development Information

Time (Finish): 12:

Water Level:

Total Depth of Well:

Approximate Volume Removed: 0.8 Gallons

Water Characteristics

Color Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 5.68 Temperature(°C) 19.9
Specific Conductance(μS/cm) 129
Disolved Oxygen (mg/L) 2.82

Comments: Redox -60

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MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, LF6
Well Number LF6-MPK

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/15, 1996
Measurement Datum TOC

Pre-Development Information

Time (Start): 318

Water Level: 14.0

Total Depth of Well: 16.5

Water Characteristics

Color Brown Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 6.20 Temperature(°C) 20.2
Specific Conductance(μS/cm) 502
Disolved Oxygen (mg/L) 0.93
Redox -0.7

Interim Water Characteristics

Gallons Removed 0.3

pH 6.30

Temperature (°C) 20.6

Specific Conductance(μS/cm) 516

Disolved Oxygen (mg/L) 0.62

Redox -0.6

Post-Development Information

Time (Finish): 345

Water Level:

Total Depth of Well:

Approximate Volume Removed: 2.5 gallons

Water Characteristics

Color Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 6.18 Temperature(°C) 20.5
Specific Conductance(μS/cm) 504
Disolved Oxygen (mg/L) 0.78

Comments: Redox -1.0

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MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020 Job Name: AFCEE-RNA

Location Columbus AFB, LF6 by RN/JH/CS/BL Date: 11/15, 1996

Well Number LF6-MPB Measurement Datum TOC sticking up still

Pre-Development Information Time (Start): 1140

Water Level: 11.75 (TOC) Total Depth of Well: 17.10 (TOC)

11.35 (BLS) 16.70 (BLS)

Water Characteristics

Color very cloudy red-brown Clear Cloudy

Odor: None Weak Moderate Strong

Any Films or Immiscible Material —

pH 6.30 Temperature(°C) 20.5

Specific Conductance(μS/cm) 247

Disolved Oxygen (mg/L) 0.63

Redox 62

Interim Water Characteristics

Gallons Removed 0.5 gallons Time = 11:54

pH ~~6.30~~ 5.84

Temperature (°C) 20.4

Specific Conductance(μS/cm) 268

Disolved Oxygen (mg/L) 0.71

Redox 41

Post-Development Information Time (Finish): 1204

Water Level: Total Depth of Well: 17.10

Approximate Volume Removed: 1 gallon

Water Characteristics

Color Slightly Cloudy Clear Cloudy

Odor: None Weak Moderate Strong

Any Films or Immiscible Material —

pH 5.67 Temperature(°C) 20.5

Specific Conductance(μS/cm) 268

Disolved Oxygen (mg/L) 0.28

Comments: Redox 46.

$$\begin{array}{r} 17.10 \\ 11.75 \\ \hline 5.35 \end{array} \times .10 = 0.53 \text{ gallon}$$

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, LF6
Well Number LF6-MPM

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/13/ 1996
Measurement Datum TOC

Pre-Development Information

Time (Start): 335 pm

Water Level: 12.5'

Total Depth of Well: 18.5'

Water Characteristics

Color brown Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 5.59 Temperature(°C) 17.5
Specific Conductance(µS/cm) 79
Disolved Oxygen (mg/L) 5.90

Interim Water Characteristics

Gallons Removed 0.5 1600 = time

pH 5.53

Temperature (°C) 18.7

Specific Conductance(µS/cm) 62

Disolved Oxygen (mg/L) 6.96

Post-Development Information

Time (Finish): 1613

Water Level: 12.5

Total Depth of Well: 18.5'

Approximate Volume Removed: 1.25 gallons

Water Characteristics

Color sli, Ltly gray Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 5.48 Temperature(°C) 19.1
Specific Conductance(µS/cm) 61
Disolved Oxygen (mg/L) 6.18

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, LF6
Well Number LF6-MPN

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/17, 1996
Measurement Datum TOC

Pre-Development Information

Time (Start): 655

Water Level: 20.2

Total Depth of Well: 23.6

Water Characteristics

Color Brown Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 6.60 Temperature(°C) 17.2
Specific Conductance(µS/cm) 13
Disolved Oxygen (mg/L) 1.35
Redox 151

Interim Water Characteristics

Gallons Removed 0.5 Time 706

pH 6.75

Temperature (°C) 18.0

Specific Conductance(µS/cm) 597

Disolved Oxygen (mg/L) 1.02
Redox -55

Post-Development Information

Time (Finish): 7

Water Level:

Total Depth of Well:

Approximate Volume Removed: 3/4 gallon

Water Characteristics

Color Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 6.77 Temperature(°C) 18.3
Specific Conductance(µS/cm) 599
Disolved Oxygen (mg/L) 0.33

Comments: Redox -54

23.6
-20.2
3.4/10 = 0.34 gallons

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MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020 Job Name: AFCEE-RNA
Location Columbus AFB, LF6 by RN/JH/CS/BL Date: 11/14, 1996
Well Number MPO Measurement Datum Ground surface

Pre-Development Information Time (Start): 710

Water Level: DTW = 4.5' Total Depth of Well: 14.5'

Water Characteristics

Color slightly cloudy gray Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 4.83 Temperature(°C) 17.8
Specific Conductance(μS/cm) 672
Disolved Oxygen (mg/L) 1.18

Interim Water Characteristics

Gallons Removed 1 Time 7:16

pH 4.75

Temperature (°C) 18.5

Specific Conductance(μS/cm) 86.6

Disolved Oxygen (mg/L) 0.46

Post-Development Information Time (Finish): 725

Water Level: can't measure w/ tube in point Total Depth of Well: 14.5

Approximate Volume Removed: 1.8 gall

Water Characteristics

Color slightly gray Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 4.80 Temperature(°C) 18.8
Specific Conductance(μS/cm) 86.0
Disolved Oxygen (mg/L) 0.27

Comments:

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MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, LF6
Well Number LF6-MPP

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/14, 1996
Measurement Datum Ground Surface

Pre-Development Information

Time (Start): 0850

Water Level: 5.3'

Total Depth of Well: 13.7'

Water Characteristics

Color ORANGE BROWN Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material
pH 5.67 Temperature(°C) 17.2
Specific Conductance(µS/cm) 385
Disolved Oxygen (mg/L) 4.02

Interim Water Characteristics

Gallons Removed 0.6

pH 5.13

Temperature (°C) 18.3

Specific Conductance(µS/cm) 239

Disolved Oxygen (mg/L) 0.93

Post-Development Information

Time (Finish): 0905

Water Level:

Total Depth of Well:

Approximate Volume Removed:

Water Characteristics

Color lt. suspended solids Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material
pH 4.89 Temperature(°C) 18.6
Specific Conductance(µS/cm) 218
Disolved Oxygen (mg/L) ~~4.05~~ 0.48

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, LF6
Well Number MPQ (LF6)

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/14, 1996
Measurement Datum TOC

Pre-Development Information

Time (Start): 1540

Water Level: 4.2

Total Depth of Well: 14.0

Water Characteristics

Color Slightly cloudy Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 6.01 Temperature(°C) 18.0
Specific Conductance(μS/cm) 758
Disolved Oxygen (mg/L) 4.28

Interim Water Characteristics

Time = 1612

Gallons Removed 0.75

pH 6.00

Temperature (°C) 18.0

Specific Conductance(μS/cm) 581

Disolved Oxygen (mg/L) 4.31

Post-Development Information

Time (Finish):

Water Level:

Total Depth of Well:

Approximate Volume Removed:

Water Characteristics

Color Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material
pH Temperature(°C)
Specific Conductance(μS/cm)
Disolved Oxygen (mg/L)

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020 Job Name: AFCEE-RNA
Location Columbus AFB, ST24 by RN/JH/CS/BL Bmit Date: 11/17, 1996
Well Number LF06 - MPR Measurement Datum Top PVC

Pre-Development Information Time (Start): 1220

Water Level: 4.42' TPVC Total Depth of Well: 14.7' TPVC

DWL-TD = 10.28'
Casing Vol. = 0.105 gal.
10 x CV = 1.05 gal.

Water Characteristics

Color Brown Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material None
pH 5.12 Temperature(°C) 19.4°C
Specific Conductance(µS/cm) 650
Disolved Oxygen (mg/L) 0.65

Interim Water Characteristics

Time	1225	1230	1235	1240
Gallons Removed	0.5	1.0	1.5	2.0
pH	5.10	5.15	5.02	5.01
Temperature (°C)	19.2	19.2	19.2	19.2
Specific Conductance(µS/cm)	650	700	720	700
Disolved Oxygen (mg/L)	0.61	0.64	0.21	0.16
Redox	133	76.4	66.8	64.3

Post-Development Information Time (Finish): 1240

Water Level: NR Total Depth of Well: 14.7' PVC

Approximate Volume Removed: 2.0 gal.

Water Characteristics

Color Clear Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material None
pH 5.01 Temperature(°C) 19.2°C
Specific Conductance(µS/cm) 700
Disolved Oxygen (mg/L) 0.15

Comments:

APPENDIX A-3

GROUNDWATER SAMPLING FORMS

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL W18
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/15/96, 1996 1520 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER:
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC 17.55
GSurface 14.4

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH isopropanol and distilled water
Items Cleaned (List): Probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH 17.55 (TOC) 14.40 (BLS) FT. BELOW DATUM
Measured with: Solinst

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: cloudy → slightly cloudy
Odor: —
Other Comments: Line clogged initially and water was cloudy brown but after clogging water cleared

4 [ ] WELL EVACUATION:
Method: Peristaltic pump
Volume Removed:
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors:
Other comments:

TD 37.0
DTW 14.5

$22.5 / 2 = 11.25$ ~~...~~ gallons

Groundwater Sampling Record

Monitoring Well No. W18 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

145 15

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	1302	1345	1425	1450	1515	Meausred with
Temp (°C)	19.7	19.6	19.4	19.3	19.3	45I SS
pH	5.50	5.66	5.59	5.57	5.57	Orion 250A
Cond (µS/cm)	252	263	258	249	245	Hach Meter
DO (mg/L)	0.71	0.20	0.19	0.17	0.16	45I SS
Redox (mV)	94	88	94.5	99.7	100	Orion 250A
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						
gallons	0.8	4	8	10	11	

7 [ ] SAMPLE CONTAINERS (material, number, size):
10 VOAs
1 Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method ____ Containers: ____
Method ____ Containers: ____
Method ____ Containers: ____

[X] Preservatives added:

Method HCl Containers: VOAs
Method ____ Containers: ____
Method ____ Containers: ____
Method ____ Containers: ____

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[X] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL LF06-W19
(number)

REASON FOR SAMPLING: ~~[X]~~ Regular Sampling; [X] Special Sampling; PNA
DATE AND TIME OF SAMPLING: 11/17/96, 1996 1050 a.m./p.m.
SAMPLE COLLECTED BY: ~~JH/BL/~~CS/RN of Parsons ES
WEATHER: BM/CS Cloudy Raining - 60°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): Top of PVC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: Good
INNER PVC CASING CONDITION IS: Good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off
1 [ ] EQUIPMENT CLEANED BEFORE USE WITH Alconox / DI Water / Isopropanol / DI
Items Cleaned (List): Water Level Indicator - Not Working

2 [ ] PRODUCT DEPTH NA FT. BELOW DATUM
Measured with:

WATER DEPTH 19.5' - Measured last week FT. BELOW DATUM
Measured with: TD = 31.5 2" PVC - 12' saturated

Casing Volume = 2.0 gal.
Purge Volume = 6.0 gal.

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Clear
Odor: None
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic Pump
Volume Removed: 6.0 gal.
Observations: Water (slightly - very) cloudy Clear
Water level (rose - fell - no change) NR
Water odors: None
Other comments:

Time	Volume	pH	Temp	DO	mV	EC	Comment	Analytical
1008	1.0	—	19.6	2.48	490?	90	Clear	VOCs / BTEX / TVH-G / Metals
1015	2.0	5.10	19.6	2.35	463?	85	"	Anions / Cations
[illegible]	3.0	5.05	19.6	2.28	286	80	"	
[illegible]3	4.0	5.15	19.6	2.26	283	82	Clear	
1040	5.0	5.16	19.6	2.27	288	85	"	
1047	6.0	5.18	19.6	2.25	284	85	Clear	→ FINAL

SAMPLE AT 1050

Groundwater Sampling Record

Monitoring Well No. LF06-W19 (Cont'd)

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[✓] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [✓] ON-SITE MEASUREMENTS:

See Page 1

Time						Meausred with
Temp (°C)						
pH						
Cond (µS/cm)						
DO (mg/L)						
Redox (mV)						
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						

7 [X] SAMPLE CONTAINERS (material, number, size): 10 VOAs w/ HCL
1 x 125 ml Plastic
2 Glass Mason Jars

8 [✓] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: NA Method Containers:
Method Containers:
Method Containers:

[ ] Preservatives added: All HCL except Anions

Method VOCs Containers:
Method BTEX / TVH-G Containers:
Method Methane Containers:
Method Anions Containers:

9 [X] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [✓] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL W20
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/14, 1996 1515 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: 65 Clear
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH isopropanol + distilled water
Items Cleaned (List): probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH 5.3 (3.8 below ground) FT. BELOW DATUM
Measured with: Solinst

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Clear
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic pump
Volume Removed: 10.5 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors:
Other comments:

23 TD
3.8
19.2 / 2 = 9.6 gallons ⇒ 10

Groundwater Sampling Record

Monitoring Well No. W20 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS: Begin purge 1400

Time	~~1400~~ 1418	1430	1440	1453	1506	Meausred with
Temp (°C)	17.9	17.7	17.7	17.6	17.6	YSI 55
pH	4.60	4.57	4.47	4.48	4.48	Orion 250A
Cond (µS/cm)	61	64	63	63	63	Hach Meter
DO (mg/L)	0.99	0.75	0.66	0.63	0.64	YSI 55
Redox (mV)	234	251	302	248	254	Orion 250A
Salinity	~~11.8~~					~~YSI 55~~
Nitrate						
Sulfate						
Ferrous Iron						
gallons	1	4	6	8	10	

7 [ ] SAMPLE CONTAINERS (material, number, size):
10 VOAs
2 Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method Containers:
Method Containers:
Method Containers:

[X] Preservatives added:

Method HCl Containers: VOAs
Method Containers:
Method Containers:
Method Containers:

9 [ ] CONTAINER HANDLING:

[✓] Container Sides Labeled
[X] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL W21
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/14 1996 1320 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER:
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH Isopranol and distilled water
Items Cleaned (List): Probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH 8.5 Previous FT. BELOW DATUM
Measured with: Solinst

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Clear
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic
Volume Removed: 11.5 gallons
Observations: Water (~~slightly~~ - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments:

28 TD
-6 DTW (Ground surface)
22/2 = 11 gallons

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Groundwater Sampling Record

Monitoring Well No. W21 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS: Began purge 11:55

Time	1202	1226	1250	1302	1315	Measured with
Temp (°C)	17.0	17.1	17.1	17.2	16.9	YSI 55
pH	4.34	4.73	4.76	4.34	4.33	Orion 250A
Cond (µS/cm)	242	244	242	241	240	Hach Meter
DO (mg/L)	0.43	6.28	0.19	0.18	0.17	YSI 55
Redox (mV)	199	204	215	221	215.7	Orion 250A
Salinity	~~4.5~~	~~2.9~~	~~2.0~~	~~1.9~~		~~YSI 55~~
Nitrate						
Sulfate						
Ferrous Iron						

gallons 1.0 4 7 9

7 [ ] SAMPLE CONTAINERS (material, number, size):
10 VOAs
2 Poly
1 Glass Amber

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method Containers:
Method Containers:
Method Containers:

[X] Preservatives added:

Method HCl Containers: VOAs
Method Sulfuric Containers: Glass amber
Method Containers:
Method Containers:

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[X] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL W-22
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/13/ , 1996 1750 a.m. p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parson's ES
WEATHER: 55 Cloudy
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off
1 [ ] EQUIPMENT CLEANED BEFORE USE WITH ISOPROPANOL + distilled water
Items Cleaned (List):

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH 10.15 FT. BELOW DATUM
Measured with: Solinst water level indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Slightly gray
Odor: None
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic pump
Volume Removed:
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors:
Other comments:

DTW (from ground)	TD (from ground)
7.5	21.5

$\frac{14}{2} = 7$ gallons

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Groundwater Sampling Record

Monitoring Well No. ~~B~~ W22 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: ______
[X] Pump, type: Peristaltic
[ ] Other, describe: ______

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	1658	1713	1727	1734	1745	Meausred with
Temp (°C)	19.5	20.2	20.2	20.1	20.2	YSI 55
pH	4.72	4.65	4.69	4.68	4.63	Orion 250A
Cond (µS/cm)	74	65	64	63	62	Hach meter
DO (mg/L)	0.95	0.51	0.53	0.55	0.56	YSI 55
Redox (mV)	283	207	269	172	175	Orion 250A
Salinity	10.1	6.0	5.7	6.2	6.2	YSI 55
Nitrate						
Sulfate						
Ferrous Iron						
gallons	1	3	5	6		

7 [ ] SAMPLE CONTAINERS (material, number, size): ______
10 VOAS
2 Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method______ Containers:______
Method______ Containers:______
Method______ Containers:______

[ ] Preservatives added:

Method HCl Containers: VOAs
Method______ Containers:______
Method______ Containers:______
Method______ Containers:______

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[X] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: W1 is duplicate
time labeled at 630pm

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL W 78
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/14 1996 1110 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: 62° Cloudy
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH Isopropanol and Distilled Water
Items Cleaned (List): Probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH 8.1 previous FT. BELOW DATUM
Measured with: Solinst

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Clear
Odor: none
Other Comments: —

4 [ ] WELL EVACUATION:
Method: Peristaltic
Volume Removed: 1 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments:

Groundwater Sampling Record

Monitoring Well No. W78 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS: Begin Purge At 1010

Time	1013	1024	1035	1051	110	Meausred with
Temp (°C)	17.9	18.3	18.4	18.7	18.7	YSI 55
pH	4.51	4.55	4.47	4.65	4.48	Orion 250A
Cond (µS/cm)	158	182	189	199	198	Hach Meter
DO (mg/L)	0.73	0.54	0.45	0.30	0.29	YSI 55
Redox (mV)	139.3	158.2	163.0	185	184	Orion 250A
Salinity	7.1	5.8	4.8	3.1	3.2	YSI 55
Nitrate						
Sulfate						
Ferrous Iron						

0.5 gallon 2 gallons 3 gallons 5 gall

7 [ ] SAMPLE CONTAINERS (material, number, size):
10 VOAs
2 Poly
1 Glass amber

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method ______ Containers: ______
Method ______ Containers: ______
Method ______ Containers: ______

[ ] Preservatives added:

Method HCl Containers: VOAs
Method Sulfuric Containers: Glass amber
Method ______ Containers: ______
Method ______ Containers: ______

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[X] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: Duplicate W2
TVH and VOAs only

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - KF62
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL W79
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/15, 1996 745 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: 55° Clear
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:

[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH isopropanol +
Items Cleaned (List): Probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH 8.9 (TOC) 5.9 (BLS) FT. BELOW DATUM
Measured with: Solinst

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Cloudy brown
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic Pump
Volume Removed:
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments:

$$\begin{array}{r} 20 \\ -\ 6 \\ \hline 14 \end{array} / 2 = 7 \text{ gallons}$$

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Groundwater Sampling Record

Monitoring Well No. MW79 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	650	707	713	725	735	Meausred with
Temp (°C)	17.3	17.4	17.3	16.9	16.9	YSI 55
pH	~~[illegible]~~	4.57	4.42	4.59	4.65	Orion 250A
Cond (µS/cm)	47	45	45	44	44	Hach Meter
DO (mg/L)	3.25	3.33	2.91	3.05	2.88	YSI 55
Redox (mV)	147	156	166	170	181	Orion 250A
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						
gal	2	4	5	6		

7 [ ] SAMPLE CONTAINERS (material, number, size):
10 VOAs
2 Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method ______ Containers: ______
Method ______ Containers: ______
Method ______ Containers: ______

[X] Preservatives added:

Method HCl Containers: VOAs
Method ______ Containers: ______
Method ______ Containers: ______
Method ______ Containers: ______

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[X] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL W81 (LF6)
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/13, 1996 ________ a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: 60° Overcast
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off
1 [ ] EQUIPMENT CLEANED BEFORE USE WITH Isopropanol and distilled water
Items Cleaned (List): Probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH 16.61 FT. BELOW DATUM
Measured with: Solinst water level indicator previously

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: cloudy brown
Odor: none -
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic
Volume Removed: 2 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments:

Groundwater Sampling Record

Monitoring Well No. W81 (LF6) (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type:
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	~~1427~~ 1427	1435	1440	1444		Meausred with
Temp (°C)	19.8	20.0	20.0	20.0		YSI 55
pH	6.12	6.16	6.15	6.16		Orion 290A
Cond (µS/cm)	653	624	620	624		Hach meter
DO (mg/L)	0.33	0.23	0.23	0.20		YSI 55
Redox (mV)	-48	-61.1	-63.0	-64.6		Orion 290A
Salinity						
Nitrate						
Sulfate						
gallons ~~Ferrous Iron~~	0.5	1.0	1.5	2.0		

7 [ ] SAMPLE CONTAINERS (material, number, size):
10 VOAs
1 Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method___ Containers:___
Method___ Containers:___
Method___ Containers:___

[ ] Preservatives added:

Method HCl Containers: VOAs
Method___ Containers:___
Method___ Containers:___
Method___ Containers:___

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[X] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL W82
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/15 1996 ~~1000~~ 810 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: 60° breezy, sunny
DATUM FOR WATER DEPTH MEASUREMENT (Describe):

MONITORING WELL CONDITION:

[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: Good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH Isopropanol + distilled water
Items Cleaned (List): Probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH ~~10.6~~ 9.26 Previous FT. BELOW DATUM
Measured with: Solinst WL indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: slightly cloudy - brown
Odor: none
Other Comments: —

4 [ ] WELL EVACUATION:
Method: Peristaltic pump
Volume Removed: ~~Four~~ 8 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments:

24.4
9.3
15.1/2 = 7.5 gallons

Groundwater Sampling Record

Monitoring Well No. W82 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS: Began purge 820

Time	834	857	918	925	935	Meausred with
Temp (°C)	20.6	20.8	20.7	20.0	20.8	YSI 55
pH	6.98	4.21	4.35	4.64	4.42	Orion 250A
Cond (μS/cm)	60	59	58	58	58	Hach Meter
DO (mg/L)	2.08	[illegible]	2.06	1.91	2.03	YSI 55
Redox (mV)	186	190	203	227	233	Orion 250A
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						
Gallons	2	4	6	7	8	

7 [ ] SAMPLE CONTAINERS (material, number, size):
10 VOAs
2 Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method ___ Containers: ___
Method ___ Containers: ___
Method ___ Containers: ___

[X] Preservatives added:

Method HCl Containers: VOAs
Method ___ Containers: ___
Method ___ Containers: ___
Method ___ Containers: ___

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[X] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GW SAMPLING RECORD

~~MONITORING POINT DEVELOPMENT RECORD~~

Job Number: 729691.32020 Job Name: AFCEE-RNA
Location Columbus AFB, ST24 by RN/JH/CS/BL BMH Date: 11/18, 1996
Well Number LFO6 - 4FTRNGL1W1 Measurement Datum Top PVC

Pre-Development Information Time (Start): 1030

Water Level: 2.73 ' TPVC Total Depth of Well: 12.77 ' TPVC

Water Characteristics

1 1/2" Diameter Well
Casing Volume = .09 gal
x 10 CV = 0.92 gal.

Color Sl. Cloudy Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material None
pH 6.27 Temperature(°C) 21.1
Specific Conductance(µS/cm) 140
Disolved Oxygen (mg/L) 3.12
Redox = 320 mv.

Interim Water Characteristics

Time	1040	1044	
Gallons Removed	1.0	(Dry)	
pH	6.04		
Temperature (°C)	20.5		
Specific Conductance(µS/cm)	145		
Disolved Oxygen (mg/L)	3.08		
Redox	61.2		

- Well Bailed Dry at 1.0 gallons.
- Water Level = 12.70' TPVC.
- Water level at 10 min. = 12.70 TPVC

Water Not Rising → Dry Well - Did not Sample

Post-Development Information Time (Finish):

Water Level: Total Depth of Well:

Approximate Volume Removed:

Water Characteristics

Color Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material
pH Temperature(°C)
Specific Conductance(µS/cm)
Disolved Oxygen (mg/L)

Comments:

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL LF6A - 4F8RNIW2

(number)

REASON FOR SAMPLING: ~~[X] Regular Sampling~~; [X] Special Sampling; RNA
DATE AND TIME OF SAMPLING: 11/17/96, 1996 [illegible] → Could not sample
SAMPLE COLLECTED BY: ~~JH/BL/~~CS/RN of Parsons ES BMH
WEATHER: Cloudy, 60°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): Top PVC - Highest Point on Cut

MONITORING WELL CONDITION:

[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: OK
INNER PVC CASING CONDITION IS: OK
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [X] EQUIPMENT CLEANED BEFORE USE WITH Liquinox / Alconox / Isopropanol / DI Water
Items Cleaned (List): Water Level Indicator
Probes + Flow Through Cell

2 [X] PRODUCT DEPTH NA FT. BELOW DATUM
Measured with:

WATER DEPTH 7.35' TPVC / TD = 14.6' TPVC / 1½" PVC FT. BELOW DATUM
Measured with: Solinst Water Level Indicator
Casing Volume = 0.75 gal. Purge Volume = 2.2 gal.

3 [X] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Clear
Odor: None
Other Comments:

4 [X] WELL EVACUATION:
Method: Peristaltic Pump
Volume Removed: 3.0+ gal.
Observations: Water (slightly - very) cloudy Clear
Water level (rose - fell - no change)
Water odors: None
Other comments:

NOTE:

Bailed Dry, did not recover in 24 hrs, Not Sampled

Groundwater Sampling Record

Monitoring Well No. LF06-4FBRN-1WZ (Cont'd)

SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

ON-SITE MEASUREMENTS: → Bailed dry at 1.0 gal.

Volume (gal.)	0.5	1.0	2.0	3.0		
Time	1135	1140				Meausred with
Temp (°C)	20.8	20.7				YSI 55
pH	5.84	5.70				Orion 230A
Cond (µS/cm)	60	60				YSI
DO (mg/L)	5.50	5.6				YSI 55
Redox (mV)	200	198				
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						

SAMPLE CONTAINERS (material, number, size): 10 VOAs / 1 - 125 ml Plastic / 2 Mason Jars

ON-SITE SAMPLE TREATMENT:

[ ] NA Filtration: Method ____ Containers: ____
Method ____ Containers: ____
Method ____ Containers: ____

[ ] Preservatives added: – All HCL except Anions

Method ____ Containers: ____
Method ____ Containers: ____
Method ____ Containers: ____
Method ____ Containers: ____

CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

OTHER COMMENTS: Bailed dry at 1.0 gal. – Did not Recover. Leave well to sample later

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL LF6-MPA(D)
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/17/96, 1996 445 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: 65 Overcast
DATUM FOR WATER DEPTH MEASUREMENT (Describe): —

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: not complete
INNER PVC CASING CONDITION IS: Implant
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH Distilled water
Items Cleaned (List): Probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH — FT. BELOW DATUM
Measured with: —

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Cloudy brown
Odor: None
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic
Volume Removed: D 1.5 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments:

Groundwater Sampling Record

Monitoring Well No. LF6-MPA(D) (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS: poured out silty contents of erlenmeyer flask

Time	352	406	416	430	438	Meausred with
Temp (°C)	21.0	20.9	20.5	20.2	20.1	YSI 55
pH	~~3.87~~ 5.67	5.77	5.76	5.06	5.67	Orion 250A
Cond (µS/cm)	160	158	150	118	118	Hach Meter
DO (mg/L)	0.39	0.36	0.34	1.38	0.96	YSI 55
Redox (mV)	-297	-280	-238	-60	-67.5	Orion 250A
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						
Gallons	0.3	0.4	0.5	0.9	1.1	

7 [ ] SAMPLE CONTAINERS (material, number, size):
10 VOAs
1 Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method ____ Containers: ____
Method ____ Containers: ____
Method ____ Containers: ____

[X] Preservatives added:

Method HCl Containers: VOAs
Method ____ Containers: ____
Method ____ Containers: ____
Method ____ Containers: ____

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[X] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: Very slow pumping!

GROUNDWATER SAMPLING RECORD (1)

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL LF6-MPBB
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/17, 1996 ________ a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of ~~Parsons~~ ES
WEATHER: 60° Cloudy
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): ________

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH Distilled water
Items Cleaned (List): Probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH 9.4 FT. BELOW DATUM
Measured with: Solinst water level indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: ________
Odor: ________
Other Comments: ________

4 [ ] WELL EVACUATION:
Method: Peristaltic
Volume Removed: ________
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: ________
Other comments: ________

Groundwater Sampling Record

Monitoring Well No. LF6-MPB (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	156					Measured with
Temp (°C)	19.8					YSI 55
pH	5.00					Orion 250A
Cond (µS/cm)	493					Hach Meter
DO (mg/L)	1.12					YSI 55
Redox (mV)	0.7					Orion 250A
~~Salinity~~						
~~Nitrate~~						
~~Sulfate~~						
~~Ferrous Iron~~						

gallons

7 [ ] SAMPLE CONTAINERS (material, number, size):
10 VOAs
1 Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration:
Method ________ Containers: ________
Method ________ Containers: ________
Method ________ Containers: ________

[ ] Preservatives added:
Method HCl Containers: VOAs
Method ________ Containers: ________
Method ________ Containers: ________
Method ________ Containers: ________

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[X] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: allow to recharge 157-

GROUNDWATER SAMPLING RECORD (2)

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL LF06 - MPB
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [X] Special Sampling; RNA
DATE AND TIME OF SAMPLING: 11/18, 1996 1130 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES BMH
WEATHER: Cloudy - Raining 60°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): Top PVC

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: OK
INNER PVC CASING CONDITION IS: OK
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [X] EQUIPMENT CLEANED BEFORE USE WITH Water / Alconox / DI Water
Items Cleaned (List): Water level Indicator

2 [X] PRODUCT DEPTH NA FT. BELOW DATUM
Measured with:

WATER DEPTH 4.28' TPVC FT. BELOW DATUM
Measured with:

3 [X] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Sl. Cloudy - Cleared Quickly
Odor:
Other Comments:

4 [X] WELL EVACUATION:
Method: Peristaltic Pump
Volume Removed: 1 Qt. → Well Developed Dry day before
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: None
Other comments:

Groundwater Sampling Record

Monitoring Well No. LFO2-MPB (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS: None -> Well Bailed Dry day before, Sample only

Time						Meausred with
Temp (°C)						
pH						
Cond (µS/cm)						
DO (mg/L)						
Redox (mV)						
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						

7 [X] SAMPLE CONTAINERS (material, number, size): 10 VOAs w/ HCL
1x 125 ml Plast.
1x Glass Mason Jar

8 [X] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method Containers:
Method Containers:
Method Containers:

[ ] Preservatives added: All VOAs HCL

Method BTEX Containers:
Method TVH-G Containers:
Method VOCs Containers:
Method Metals Containers:

9 [X] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

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GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL LF6-MPC(5)
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/17/96, 1996 845 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: Raining 60°
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:

[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH isopropanol + distilled water
Items Cleaned (List): Probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH 19.8 FT. BELOW DATUM
Measured with: Solinst water level indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Cloudy brown
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic
Volume Removed: 0.5
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments:

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Groundwater Sampling Record

Monitoring Well No. LF6-MPC(S) (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	807	810	820	830	840	Meausred with
Temp (°C)	17.3	17.3	17.1	16.9	17.1	YSI 55
pH	6.67	6.63	~~6.09~~ 6.40	6.79	6.48	Orion 250A
Cond (µS/cm)	519	512	496	500	491	Hach Meter
DO (mg/L)	2.91	2.56	1.66	2.56	2.94	YSI 55
Redox (mV)	-68	-66	-61	-53	-44	Orions 250A
~~Salinity~~						
~~Nitrate~~						
~~Sulfate~~						
~~Ferrous Iron~~						
gallons	0.25	0.3	<0.4	<0.5	0.5	

7 [ ] SAMPLE CONTAINERS (material, number, size):
10 VOAs
1 Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method ____ Containers: ____
Method ____ Containers: ____
Method ____ Containers: ____

[ ] Preservatives added:

Method HCl Containers: VOA
Method ____ Containers: ____
Method ____ Containers: ____
Method ____ Containers: ____

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[X] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: Significant aeration due to little water in well and slow recharge. Pump is operating as low as possible while still pumping water. ~~Are~~ Aeration decreases at 812
Low volume of water DO probably overestimated

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL MPC(D) /LF6
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/17/96, 1996 1015 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: Rain 60°
DATUM FOR WATER DEPTH MEASUREMENT (Describe): estimate from shallow well

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off
1 [ ] EQUIPMENT CLEANED BEFORE USE WITH Distilled water
Items Cleaned (List): Probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH ~20 FT. BELOW DATUM
Measured with: estimate from LF6-MPC(D)

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Cloudy brown
Odor: —
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic
Volume Removed: 2 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: —
Other comments:

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Groundwater Sampling Record

Monitoring Well No. MPC(D) (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	915	928	935	1000	1011	Meausred with
Temp (°C)	16.3	17.4	17.6	17.8	17.8	YSI 55
pH	7.16	5.35	5.22	5.48	5.39	Orion 250A
Cond (µS/cm)	260	192	184	181	177	Hach Meter
DO (mg/L)	1.77	0.60	0.42	1.06	0.03	YSI 55
Redox (mV)	60	135	-13	-222.5	-300	Orion 250A
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						
	0.25	.75	1	1.5	2	

7 [ ] SAMPLE CONTAINERS (material, number, size):
10 VOAS
1 Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method ____ Containers: ____
Method ____ Containers: ____
Method ____ Containers: ____

[X] Preservatives added:

Method HCl Containers: VOAS
Method ____ Containers: ____
Method ____ Containers: ____
Method ____ Containers: ____

9 [ ] CONTAINER HANDLING:

[✓] Container Sides Labeled
[X] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL LF06- MPD (D)
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/17, 1996 1410 a.m./pm
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: Brisk Cloudy
DATUM FOR WATER DEPTH MEASUREMENT (Describe): NA - Implant

MONITORING WELL CONDITION:

[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: Good
INNER PVC CASING CONDITION IS: Good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT NA
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [X] EQUIPMENT CLEANED BEFORE USE WITH Probes & Flowthrough Cell
Items Cleaned (List): w/ DI water & Alconox

2 [X] PRODUCT DEPTH NA FT. BELOW DATUM
Measured with:

WATER DEPTH NA FT. BELOW DATUM
Measured with:

3 [X] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Slightly Cloudy
Odor: None
Other Comments:

4 [X] WELL EVACUATION:
Method: Peristaltic Pump
Volume Removed: 1.0 gallon
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change) NC
Water odors: None
Other comments:

Groundwater Sampling Record

Monitoring Well No. LFOC-MPD(D) (Cont'd)

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: ________

[X] Pump, type: Peristaltic

[ ] Other, describe: ________

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [✓] ON-SITE MEASUREMENTS:

Vol. (gal.)	2.0	2.5	3.0			
Time	1358	1400	1405			Meausred with
Temp (°C)	18.0	18.0	18.0			
pH	5.05	5.04	5.03			
Cond (µS/cm)	140	110	115			
DO (mg/L)	0.18	0.16	0.15			
Redox (mV)	92.6	95.7	96.3			
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						

7 [✓] SAMPLE CONTAINERS (material, number, size): 10 VOAs w/ HCl

125 ml Plastic

Glass Mason Jar

8 [✓] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: NA Method______ Containers:______

Method______ Containers:______

Method______ Containers:______

[✓] Preservatives added: All VOAs HCl

Method BTEX Containers:______

Method TPH-G Containers:______

Method Methane Containers:______

Method VOCs Containers:______

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled

[ ] Container Lids Taped

[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: ________

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL LFCXo- MPF(S)
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [X] Special Sampling; RNA
DATE AND TIME OF SAMPLING: 11/18, 1996 0930 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: BMH Cloudy - Rainy, 60-65 °F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOP PVC

MONITORING WELL CONDITION:

[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: Good
INNER PVC CASING CONDITION IS: Good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [X] EQUIPMENT CLEANED BEFORE USE WITH Alconox / Isopropanol / DI Water
Items Cleaned (List): Water Level Indicator
Probes & Flow Through Cell

2 [X] PRODUCT DEPTH NA FT. BELOW DATUM
Measured with:

WATER DEPTH 2.48' TPVC FT. BELOW DATUM
Measured with: Solinst

3 [X] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Sl. Cloudy
Odor: None
Other Comments:

4 [X] WELL EVACUATION:
Method: Peristaltic Pump
Volume Removed: 1.5 gal.
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change) NC
Water odors: None
Other comments:

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Groundwater Sampling Record

Monitoring Well No. LFCX5-MPF(S) (Cont'd)

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[✓] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [✓] ON-SITE MEASUREMENTS:

Time	0915	0924	0930			Measured with
Temp (°C)	17.6	17.5	17.5			
pH	6.24	6.33	6.32			
Cond (µS/cm)	800	820	820			
DO (mg/L)	0.34	0.19	0.22			
Redox (mV)	-107.3	-130.3	-121.7			
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						

7 [✓] SAMPLE CONTAINERS (material, number, size): 10 VOAs w/ HCL
1x 125 ml Plastic
2x Glass Mason Jars

8 [✓] ON-SITE SAMPLE TREATMENT:

[-] Filtration: NA Method ______ Containers: ______
Method ______ Containers: ______
Method ______ Containers: ______

[✓] Preservatives added: All VOAs HCL

Method BTEX / TVH-G Containers: ______
Method Methane Containers: ______
Method VOCs Containers: ______
Method Anions Containers: ______

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL LF06-MPF(D)
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/17, 1996 1650 a.m./p.m.
SAMPLE COLLECTED BY: ~~JH/BL/CS/RN~~ of Parsons ES TSM HT
WEATHER: Cloudy
DATUM FOR WATER DEPTH MEASUREMENT (Describe): NA - Implant

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: OK
INNER PVC CASING CONDITION IS: OK
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT NA
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off
1[ ] EQUIPMENT CLEANED BEFORE USE WITH Alconox / DI Water
Items Cleaned (List): Probes + Flow Through Cell

2[✓] PRODUCT DEPTH NA FT. BELOW DATUM
Measured with:

WATER DEPTH NA FT. BELOW DATUM
Measured with:

3[✓] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Slightly Cloudy
Odor: None
Other Comments:

4[✓] WELL EVACUATION:
Method: Peristaltic Pump
Volume Removed: 0.4 gal.
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change) NA
Water odors: None
Other comments:

Groundwater Sampling Record

Monitoring Well No. LF06-MPF(D) (Cont'd)

5 [X] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:

[X] Pump, type: Peristaltic Pump

[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [X] ON-SITE MEASUREMENTS:

Vol. (gal)	0.6	1.0				
Time	1635	1650				Measured with
Temp (°C)	18.4	18.4				
pH	6.49	6.48				
Cond (µS/cm)	600	620				
DO (mg/L)	2.55	2.11	→ Sucking Air-Bubbling			
Redox (mV)	-13.7	-15.0				
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						

NOTE: Initial DO = 0.45 mg/L before bubbli

7 [ ] SAMPLE CONTAINERS (material, number, size): 10 VOAs
125 ml Plastic
1X Glass Mason Jar

8 [X] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method___ Containers:___
Method___ Containers:___
Method___ Containers:___

[X] Preservatives added: All VOAs HCL

Method BTEX Containers:
Method TVH-G Containers:
Method Methane Containers:
Method VOCs Containers:

9 [X] CONTAINER HANDLING:

[X] Container Sides Labeled

[ ] Container Lids Taped

[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL LF06-MP6
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [X] Special Sampling; RNA
DATE AND TIME OF SAMPLING: 11/18, 1996 0800 a.m./p.m.
SAMPLE COLLECTED BY: JH/~~BL/CS/RN~~ of Parsons ES
WEATHER: Bmit Cloudy, Rainy, 60°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): Top PVC

MONITORING WELL CONDITION:

[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: Good
INNER PVC CASING CONDITION IS: Good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [X] EQUIPMENT CLEANED BEFORE USE WITH Alconox/Isopropanol/DI Water
Items Cleaned (List): Water Level Indicator
Probes + Flow Through Cell

2 [X] PRODUCT DEPTH NA FT. BELOW DATUM
Measured with:

WATER DEPTH 14.87' FT. BELOW DATUM
Measured with: Solinst

3 [X] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Sl. Cloudy
Odor: None
Other Comments:

4 [X] WELL EVACUATION:
Method: Peristaltic Pump
Volume Removed: 0.4 gal.
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change) → slow recharge
Water odors: None
Other comments:

Groundwater Sampling Record

Monitoring Well No. LF06-MP6 (Cont'd)

5 [X] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [X] ON-SITE MEASUREMENTS:

Vol. (gal.)	0.6	1.0				
Time	0740	0800				Meausred with
Temp (°C)	17.7	17.8				
pH	6.48	6.50				
Cond (µS/cm)	110	85				
* DO (mg/L)	6.90	7.05				
Redox (mV)	-77.6	-71.3				
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						

* Slow Purge - Bubbling in Flow Line, DO not representative.

7 [X] SAMPLE CONTAINERS (material, number, size): 10 VOAs
1x 125 ml. Plastic
2x Glass Mason Jars

8 [X] ON-SITE SAMPLE TREATMENT:

[ ] NA Filtration: Method___ Containers:___
Method___ Containers:___
Method___ Containers:___

[X] Preservatives added: All VOAs HCL

Method BTEX Containers:
Method TVH Containers:
Method VOCs Containers:
Method metro Containers:

9 [X] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [X] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL LF6-MPH
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/15/96 1996 1100 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER:
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC (stick up still)

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: Not complete
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH isopropanol and distilled water
Items Cleaned (List): Probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH 8.85 FT. BELOW DATUM
Measured with: Solinst WL indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Cloudy brown
Odor: —
Other Comments: —

4 [ ] WELL EVACUATION:
Method: Peristaltic
Volume Removed: 2 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments: —

Groundwater Sampling Record

Monitoring Well No. LF6MPH (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

possibly aerated due to air in tubing

6 [ ] ON-SITE MEASUREMENTS:

Time	1000	1027	1037	1044	1052	Meausred with
Temp (°C)	18.2	19.1	19.9	19.9	19.7	YSI 55
pH	5.41	6.35	5.40	5.28	5.25	Orion 250A
Cond (µS/cm)	78	81	81	81	80	Hach Meter
DO (mg/L)	5.09	4.59	2.96	4.63	5.42	YSI 55
Redox (mV)	75	50	49	54	52	Orion 250A
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						

0.1 0.5 1 1.5 2

7 [ ] SAMPLE CONTAINERS (material, number, size):
10 VOA
2 Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method Containers:
Method Containers:
Method Containers:

[X] Preservatives added:

Method HCl Containers: VOAs
Method Containers:
Method Containers:
Method Containers:

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[X] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: at 1000 pumped turned off for well recharge til 1022

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL LF6-MPI
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/15, 1996 5:00 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: 65° Clear
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC (still sticking up)

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: Incomplete
INNER PVC CASING CONDITION IS: Good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH Isopropanol + distilled water
Items Cleaned (List): Probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH FT. BELOW DATUM
Measured with: Solinst water level indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Cloudy Brown
Odor: none
Other Comments: —

4 [ ] WELL EVACUATION:
Method: Peristaltic pump
Volume Removed:
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors:
Other comments:

Groundwater Sampling Record

Monitoring Well No. LFG-MPI (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	430	436	445	451	500	Meausred with
Temp (°C)	20.7	20.9	20.9	20.9	20.8	YSI 55
pH	5.40	5.43	5.10	5.02	5.10	Orion 250A
Cond (µS/cm)	252	241	234	231	230	Hach Meter
DO (mg/L)	1.20	0.45	0.25	0.21	0.20	YSI 55
Redox (mV)	80	104	111	112	114	Orion 250A
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						

0.5 gallon 0.8 1.3 1.8

7 [ ] SAMPLE CONTAINERS (material, number, size):
10 VOA
1 Poly
1 Glass Amber

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method Containers:
Method Containers:
Method Containers:

[ ] Preservatives added:

Method HCl Containers: VOA
Method H_2SO_4 Containers: Glass amber
Method Containers:
Method Containers:

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[X] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL LF6-MPJ
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/17, 1996 1100 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: 60° Cloudy
DATUM FOR WATER DEPTH MEASUREMENT (Describe): Ground surface (Its an implant)

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: implant
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH distilled water
Items Cleaned (List): Probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH FT. BELOW DATUM
Measured with:

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: cloudy brown-orange
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic
Volume Removed: 0.8 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments:

Groundwater Sampling Record

Monitoring Well No. LF6-MPJ (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	1109	1148	1210	1225	1248	Meausred with
Temp (°C)	17.7	18.8	20.2	20.4	19.9	YSI 55
pH	6.45	5.97	5.87	5.62	568	Orion 250A
Cond (μS/cm)	203	160	146	138	129	Hach Meter
DO (mg/L)	3.66	5.37	4.10	3.52	2.82	YSI 55
Redox (mV)	-24	-5	-48	-43	-60	Orion 250A
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						

250mL 1L 1.25L 1.5L 0.8 gallons

7 [ ] SAMPLE CONTAINERS (material, number, size):
10 VOAS
1 Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method___ Containers:___
Method___ Containers:___
Method___ Containers:___

[X] Preservatives added:

Method HCl Containers: VOAS
Method___ Containers:___
Method___ Containers:___
Method___ Containers:___

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[X] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: Clearing up at about 12:00
Slow!

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL LF6-MPK
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/15, 1996 345 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: 65° Sunny, breeze
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC (still sticking up)

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: Not complete
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH Isopropanol + Distilled Water
Items Cleaned (List): Probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH 14.0 FT. BELOW DATUM
Measured with: Solinst water level indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: ~~very slightly~~ Cloudy
Odor: None
Other Comments: —

4 [ ] WELL EVACUATION:
Method: Peristaltic pump
Volume Removed: 2.5 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments: —

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Groundwater Sampling Record

Monitoring Well No. LF6-MPK (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	320	324	330	341	345	Meausred with
Temp (°C)	20.2	20.6	20.6	20.5	20.5	YSI 55
pH	6.20	6.30	6.23	6.19	6.18	Orion 250A
Cond (μS/cm)	502	516	511	505	504	Hach Meter
DO (mg/L)	0.93	0.62	0.34	0.18	0.18	YSI 55
Redox (mV)	-0.7	-0.6	-0.3	-1.0	-1.0	Orion 250A
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						

1/16 gallon 0.3 gal 1.0 2.0 2.3

7 [ ] SAMPLE CONTAINERS (material, number, size):
10 VOAs
1 Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method ______ Containers: ______
Method ______ Containers: ______
Method ______ Containers: ______

[X] Preservatives added:

Method HCl Containers: VOAs
Method ______ Containers: ______
Method ______ Containers: ______
Method ______ Containers: ______

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[X] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL LF6-MPL
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/15 1996 1220 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: 65 Sunny breezy
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC (still sticking up)

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: not finished
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off
1 [ ] EQUIPMENT CLEANED BEFORE USE WITH isopropanol and distilled water
Items Cleaned (List): Probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH 11.75 FT. BELOW DATUM
Measured with: Solinst WL indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Cloudy red-brown
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic pump
Volume Removed: 1.5 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments:

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Groundwater Sampling Record

Monitoring Well No. LFG-MPL (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	11:47	1154	1200	1203		Meausred with
Temp (°C)	20.5	20.4	20.5	20.5		YSI SS
pH	6.08	5.84	5.66	5.67		Orion 250A
Cond (µS/cm)	361	268	268	268		Hach Meter
DO (mg/L)	0.63	0.71	0.39	0.28		YSI SS
Redox (mV)	71	41	45	46		Orion 250A
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						

gallon 0.25 0.5 1.00 1.25

7 [ ] SAMPLE CONTAINERS (material, number, size):
12 VOAs
1 Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method___ Containers:___
Method___ Containers:___
Method___ Containers:___

[X] Preservatives added:

Method HCl Containers: VOAs
Method___ Containers:___
Method___ Containers:___
Method___ Containers:___

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[X] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL MP M
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/13, 1996 1630 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: 60° Overcast
DATUM FOR WATER DEPTH MEASUREMENT (Describe): ~~TO~~ Ground surface

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: Not done
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH Isopropanol + distilled water
Items Cleaned (List): probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH 12.5 FT. BELOW DATUM
Measured with: Solinst water level indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Cloudy brown
Odor: none
Other Comments: —

4 [ ] WELL EVACUATION:
Method: Peristaltic
Volume Removed: 1.3 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments:

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Groundwater Sampling Record

Monitoring Well No. MPM (LF-6) (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS: now better DO readings

Time	1551	1600	1605	1615	1625	Meausred with
Temp (°C)	18.9	18.7	18.7	19.1	18.7	YSI SS
pH	5.50	5.53	5.58	5.48	5.43	Orion 250A
Cond (µS/cm)	68	62	62	61	62	Hach Meter
DO (mg/L)	6.38	6.96	5.18	6.20	4.88	YSI SS
Redox (mV)	692	375	81.5	92.0	660	Orion 250A
Salinity (%)	64	75.6	55.7	67.1	52.4	YSI SS
Nitrate						
Sulfate						
Ferrous Iron						

7 [ ] SAMPLE CONTAINERS (material, number, size):
10 VOAs
2 Polys

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration:
Method ____ Containers: ____
Method ____ Containers: ____
Method ____ Containers: ____

[X] Preservatives added:
Method HCl Containers: VOAs
Method ____ Containers: ____
Method ____ Containers: ____
Method ____ Containers: ____

9 [ ] CONTAINER HANDLING:

[✓] Container Sides Labeled
[✓] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: needed to surge at beginning to get flow. Low flow

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL LF6-MPN
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/17/96 1996 715 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: 60° Cloudy
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off
1 [ ] EQUIPMENT CLEANED BEFORE USE WITH isopropanol + distilled water
Items Cleaned (List): Probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH 20.2 FT. BELOW DATUM
Measured with: Solinst water level indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: cloudy brown
Odor: none
Other Comments: —

4 [ ] WELL EVACUATION:
Method: Peristaltic
Volume Removed: 3/4 - 1 gallon
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors:
Other comments:

Groundwater Sampling Record

Monitoring Well No. LF6-MPN (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:

[X] Pump, type: Peristaltic

[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	701	706	708	710	712	Measured with
Temp (°C)	17.3	18.0	18.2	18.2	18.3	YSI 55
pH	6.72	6.75	6.75	6.75	6.77	Orion 250A
Cond (µS/cm)	585	599	599	599	599	Hach Meter
DO (mg/L)	1.18	1.02	0.54	0.39	0.32	YSI 55
Redox (mV)	-54	-55	-55	-54	-55	Orion 250A
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						
gallons	1/4	1/3	1/2	5/8	3/4	

7 [ ] SAMPLE CONTAINERS (material, number, size):

10 VOAs

1 Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method ______ Containers: ______

Method ______ Containers: ______

Method ______ Containers: ______

[ ] Preservatives added:

Method HCl Containers: VOAS

Method ______ Containers: ______

Method ______ Containers: ______

Method ______ Containers: ______

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled

[X] Container Lids Taped

[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL MPO (LF6) (number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/14, 1996 730 a.m. p.m.
SAMPLE COLLECTED BY: ~~JH/BD/~~CS/RN of Parsons ES
WEATHER: 50° Overcast
DATUM FOR WATER DEPTH MEASUREMENT (Describe): Ground surface

MONITORING WELL CONDITION:

[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: not complete
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH isopropanol + distilled water
Items Cleaned (List): Probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH 4.5' FT. BELOW DATUM
Measured with: Solinst

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: ~~Slightly~~ cloudy ~~gray~~ brown
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic pump
Volume Removed:
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments:

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Groundwater Sampling Record

Monitoring Well No. MPO/LF6 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	712	716	720	722	725	Meausred with
Temp (°C)	17.8	18.5	18.8	18.8	18.8	YSI 55
pH	4.77	4.75	4.79	4.79	4.80	Orion 250A
Cond (µS/cm)	642	629	630	631	634	Hach meter
DO (mg/L)	0.85	0.46	0.40	0.39	0.26	YSI 55
Redox (mV)	100.0	86.6	84.1	84.9	86.7	Orion 250A
Salinity (%)	6.2	4.6	4.4	4.0	2.7	YSI 55
Nitrate						
Sulfate						
Ferrous Iron						

500 mLs 1 gallon 1.25g 1.5 gal 2.0 gallon

7 [ ] SAMPLE CONTAINERS (material, number, size):
10 VOAs
2 Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method ____ Containers: ____
Method ____ Containers: ____
Method ____ Containers: ____

[ ] Preservatives added:

Method HCl Containers: VOAs
Method ____ Containers: ____
Method ____ Containers: ____
Method ____ Containers: ____

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[X] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL LF6MPP
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/14/96, 1996 0920 a.m./p.m.
SAMPLE COLLECTED BY: JH/BD/CS/RN of Parsons ES
WEATHER: OVERCAST 50°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe):

MONITORING WELL CONDITION:
[ ] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS:
INNER PVC CASING CONDITION IS:
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
WELL NOT COMPLETED

Check-off
1 [ ] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List):

2 [ ] PRODUCT DEPTH ________ FT. BELOW DATUM
Measured with:

WATER DEPTH 5.3' FT. BELOW DATUM
Measured with: SOLINST

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance:
Odor:
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic
Volume Removed:
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors:
Other comments:

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Groundwater Sampling Record

Monitoring Well No. LFMPP (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:______
[ ] Pump, type:_
[ ] Other, describe:______

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	0910	0914	0918			Meausred with
Temp (°C)	18.6	18.7	18.8			
pH	4.89	4.79	4.73			
Cond (µS/cm)	212	211	208			
DO (mg/L)	0.34	0.33	0.27			
Redox (mV)	59.4	62.1	67.3			
Salinity						
Nitrate						
Sulfate						
gallons ~~Ferrous Iron~~	0.2	0.4	0.8			

7 [ ] SAMPLE CONTAINERS (material, number, size): 10 40ml glass
2 125 plastic
1 145 AMBER glass

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method______ Containers:______
Method______ Containers:______
Method______ Containers:______

[ ] Preservatives added:

Method______ Containers:______
Method______ Containers:______
Method______ Containers:______
Method______ Containers:______

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:______

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - LF6
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL LF6-MPQ
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/14/ , ~~1996~~ 1645 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: 65° Clear
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: Not complete
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH Isopropanol and distilled water
Items Cleaned (List): Probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH ~~2~~ 4.2 (TOC and GS) FT. BELOW DATUM
Measured with: Solinst

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Clear
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic pump
Volume Removed:
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors:
Other comments:

.272
11) 3.0
22
80
77
30

11 L = 3 gal
1 L = 3/11 gallon

1 L = 0.27 gallon

Groundwater Sampling Record

Monitoring Well No. LF6-MPQ (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Turned Pump off to allow for recharge (1612-)

Time	1545	1558	1606	1612	1640	Meausred with
Temp (°C)	18.0	18.1	18.0	18.0	17.5	YSI 55
pH	6.01	6.17	5.79	6.00	6.04	Orion 250A
Cond (µS/cm)	758	641	636	581	410	Hach Meter
DO (mg/L)	4.28	4.33	4.73	4.31	4.78	YSI 55
Redox (mV)	105	133	137	151	1579	Orion 250A
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						

0.1g 0.25g 0.5g 0.75g 1.00g

7 [ ] SAMPLE CONTAINERS (material, number, size):
10 VOAs
2 Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method Containers:
Method Containers:
Method Containers:

[ ] Preservatives added:

Method HCl Containers: VOAs
Method Containers:
Method Containers:
Method Containers:

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[X] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: Sample aerated
- pump is on as low as possible

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL LF06 - MPR

(number)

REASON FOR SAMPLING: [X] Regular Sampling; [X] Special Sampling; RNA
DATE AND TIME OF SAMPLING: 11/17/96, 1996 1300 a.m./pm
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: BMH Cloudy, Breezy, 60°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): Top PVC - Marked

MONITORING WELL CONDITION:

[ ] LOCKED: [✓] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: ok
INNER PVC CASING CONDITION IS: ok
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [✓] EQUIPMENT CLEANED BEFORE USE WITH Alconox / Isopropanol / DI Water
Items Cleaned (List): Water level Indicator
Probes & Flow Through Cell

2 [ ] PRODUCT DEPTH NA FT. BELOW DATUM
Measured with:

WATER DEPTH 4.42' Top PVC / TD = 14.7' Top PVC FT. BELOW DATUM
Measured with: Solinst

3 [✓] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Cloudy Brown
Odor: None
Other Comments:

4 [✓] WELL EVACUATION:
Method: Peristaltic Pump
Volume Removed:
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: None
Other comments:

Groundwater Sampling Record

Monitoring Well No. LF06-MPR (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:

[X] Pump, type: Peristaltic Pump

[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Vol. (gal.)	2.0	2.5	3.0			
Time	1240	1245	1250			Measured with
Temp (°C)	19.2	19.2	19.2			
pH	5.01	4.94	4.93			
Cond (µS/cm)	700	750	750			
DO (mg/L)	0.16	0.17	0.18			
Redox (mV)	64.3	63.6	55.9			
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						

7 [ ] SAMPLE CONTAINERS (material, number, size): 10 VOAs - All HCL
125 ml Plastic
Glass Mason Jars

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: NA Method ____ Containers: ____
Method ____ Containers: ____
Method ____ Containers: ____

[ ] Preservatives added: All VOAs HCL

Method BTEX Containers: ____
Method TPH-G Containers: ____
Method Methane Containers: ____
Method VOCs Containers: ____

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

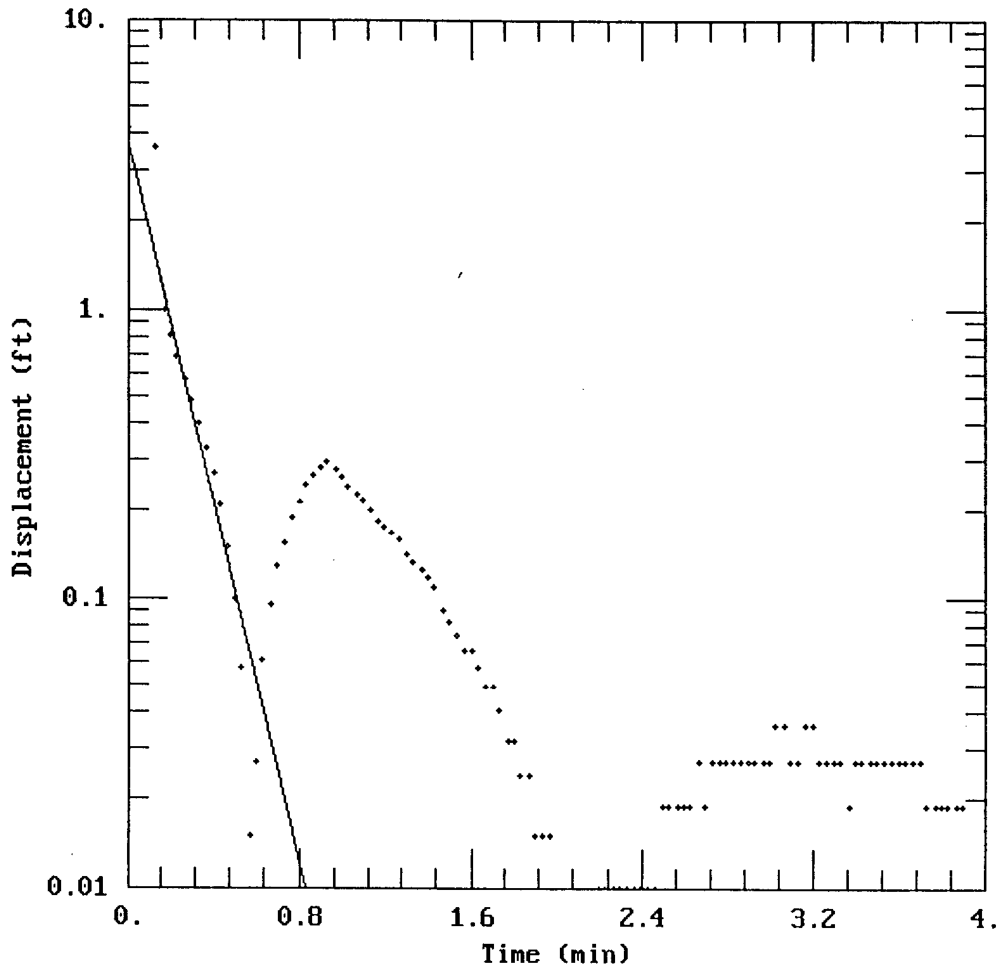
APPENDIX A-4

SLUG TEST RESULTS

CLIENT: AFCEE | COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi | PROJECT: 729691.32050

Well 82 Rising Head Test 1



DATA SET:
W8206R1.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 4.2 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.09108 ft/min
y0 = 3.695 ft

AQTESOLV

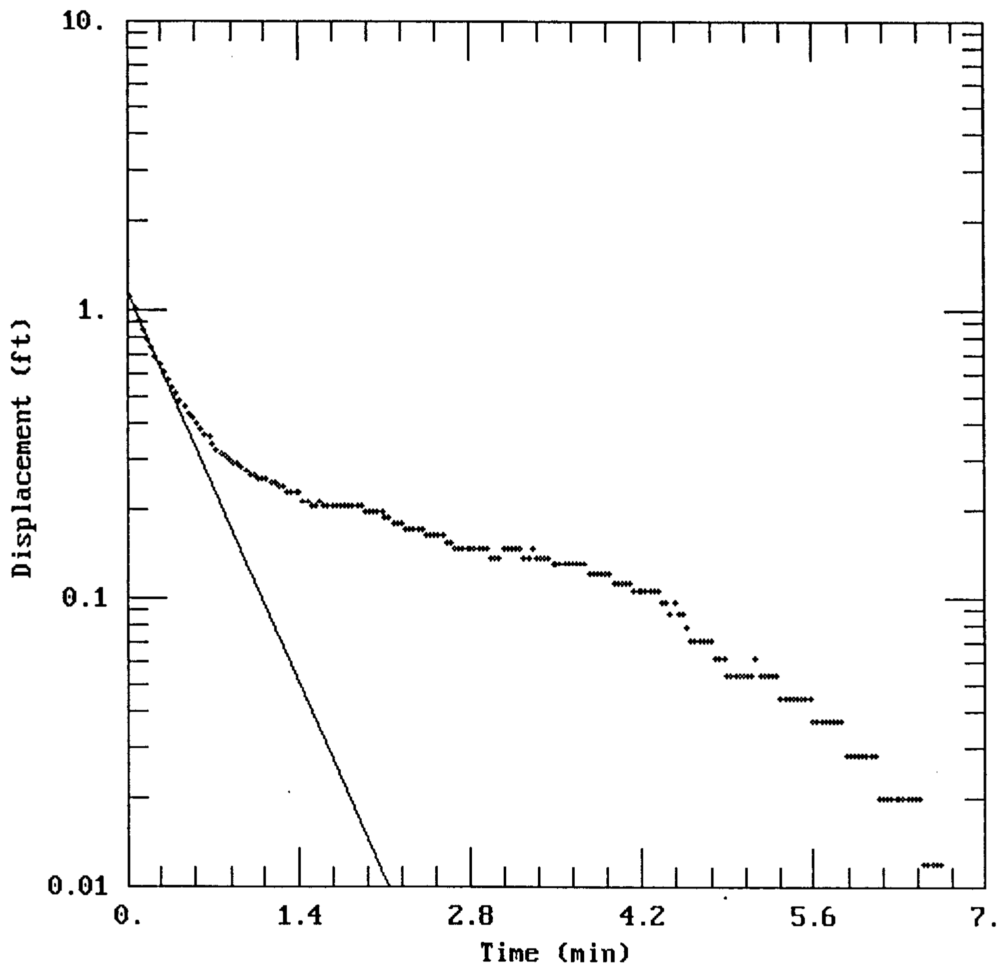
CLIENT: AFCEE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 82 Falling Head Test 1



DATA SET:
W8206I1.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 1.1 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.02846 ft/min
y0 = 1.145 ft

AQTESOLV

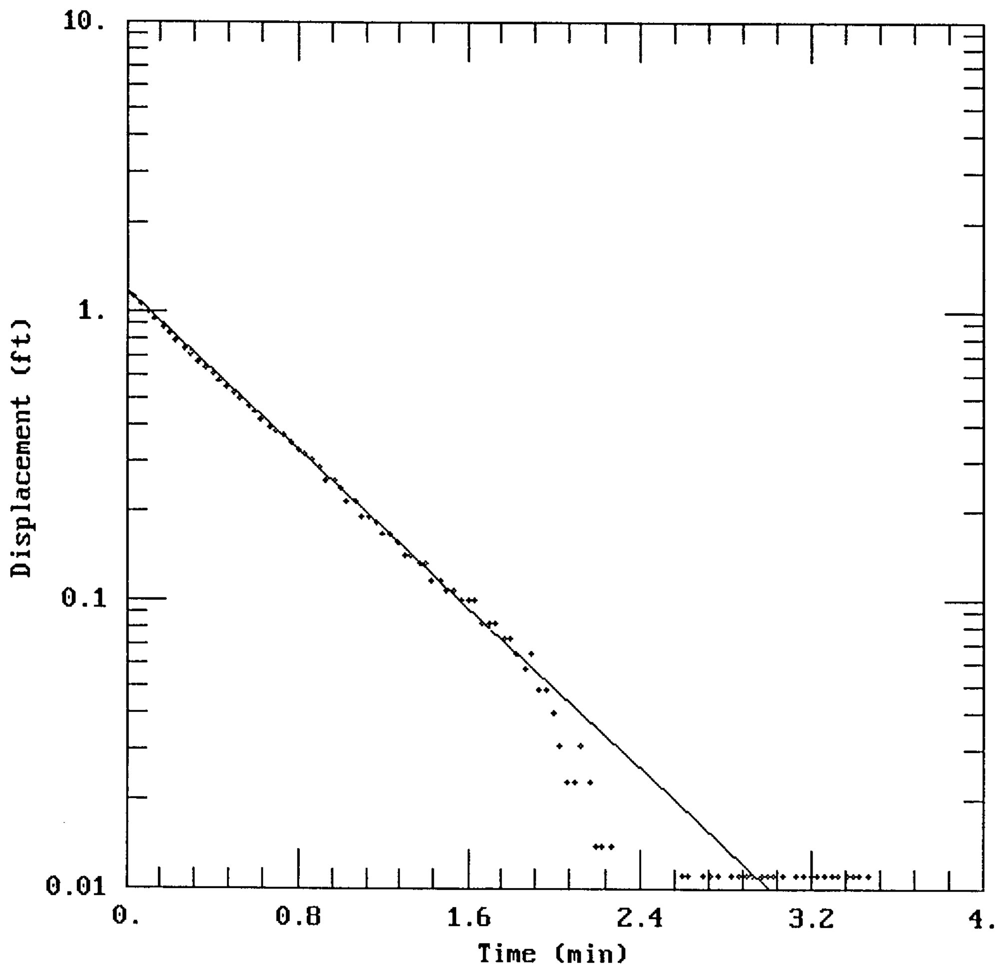
CLIENT: AFCEE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 82 Rising Head Test 2



DATA SET:
W8206R2.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 1.133 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.02021 ft/min
y0 = 1.167 ft

AQTESOLV

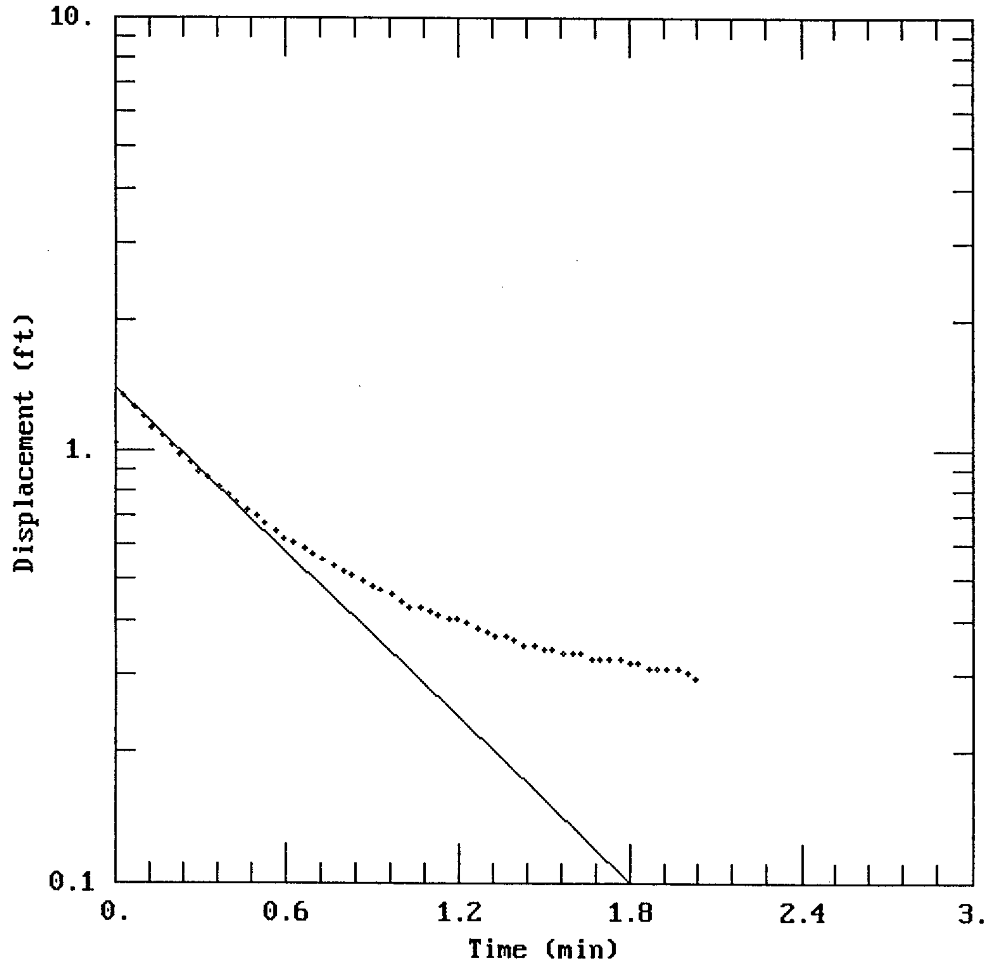
CLIENT: AFCEE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 82 Falling Head Test 2



DATA SET:
W8206I2.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

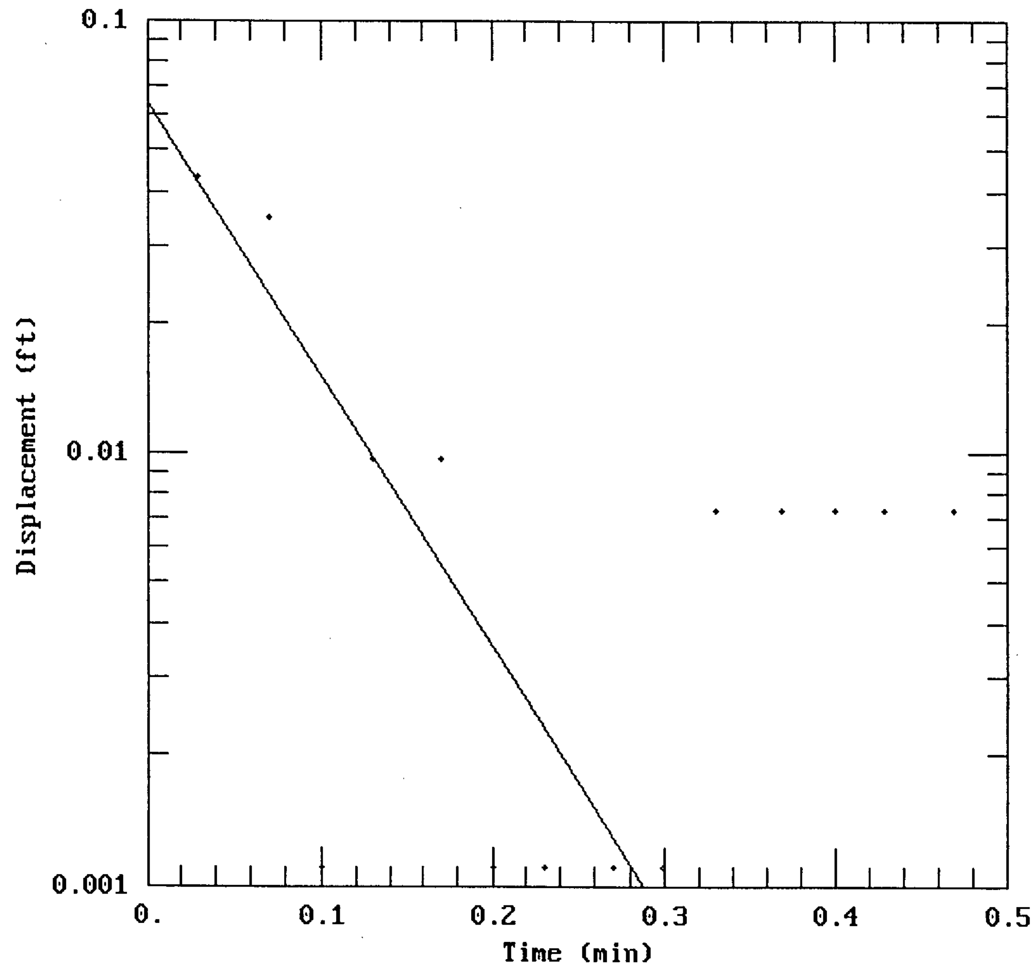
TEST DATA:
H0= 1.04 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.01866 ft/min
y0 = 1.39 ft

AQTESOLV

CLIENT: AFCEE	COMPANY: Parsons E.S.
LOCATION: Columbus AFB, Mississippi	PROJECT: 729691.32050

Well 81 Rising Head Test 1



DATA SET:
W8106R1.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.439 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.1841 ft/min
y0 = 0.06415 ft

QTESOLV

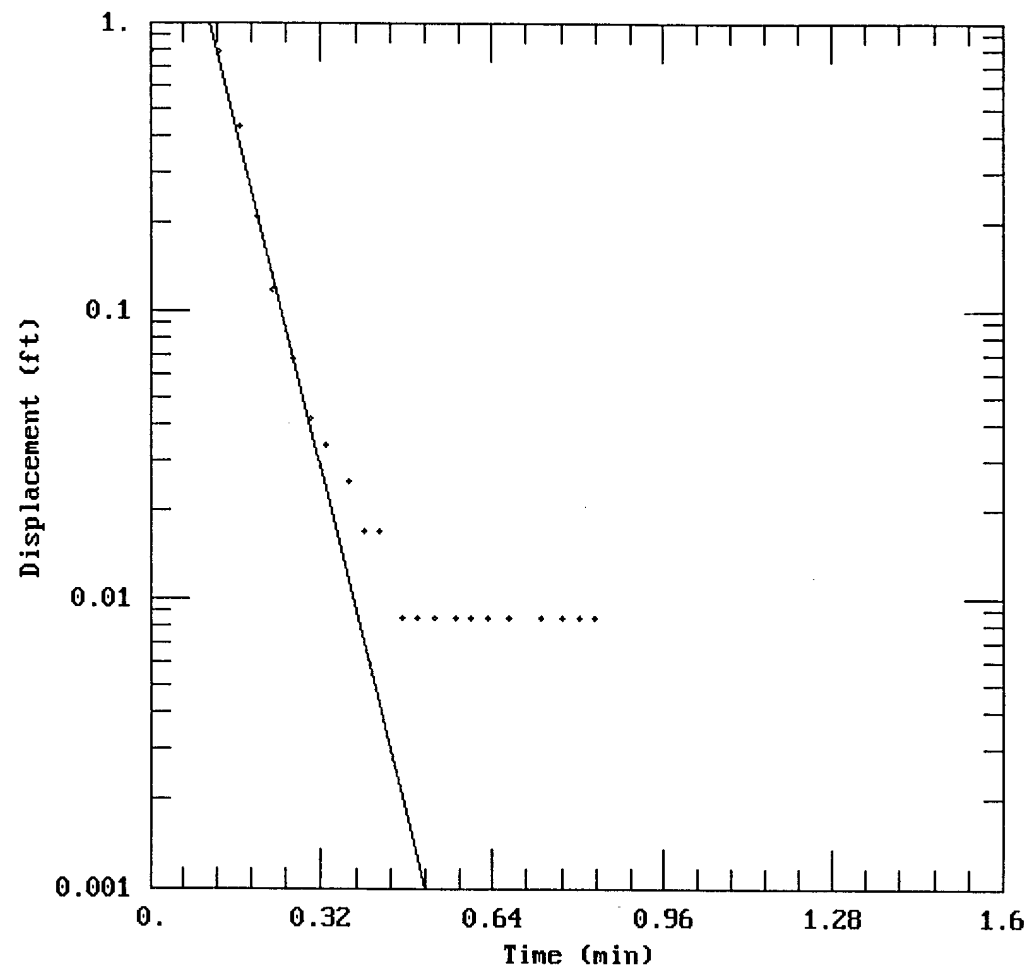
CLIENT: AFCEE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 81 Rising Head Test 2



DATA SET:
W8106R2.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.7943 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.2195 ft/min
y0 = 6.852 ft

AQTESOLV

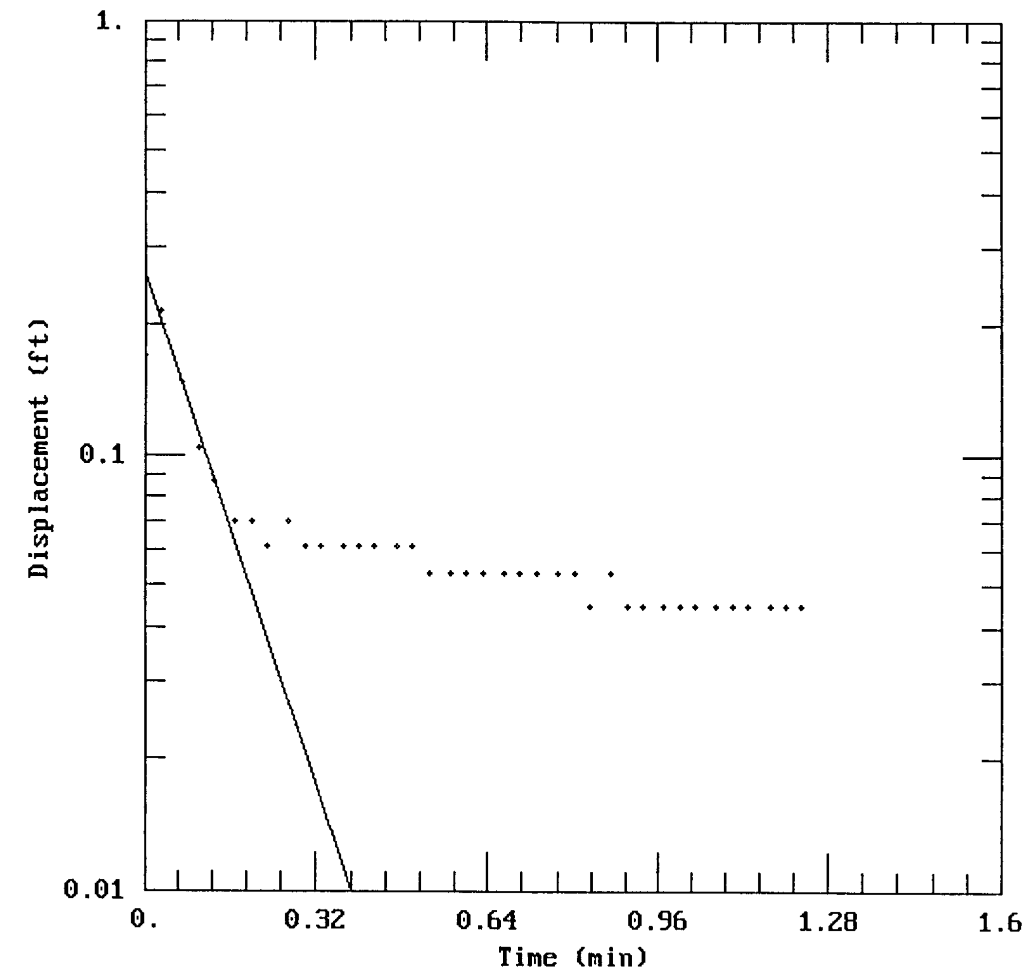
CLIENT: AFCEE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 81 Falling Head Test 2



DATA SET:
W8106I2.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.169 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.1084 ft/min
y0 = 0.2609 ft

QTESOLV

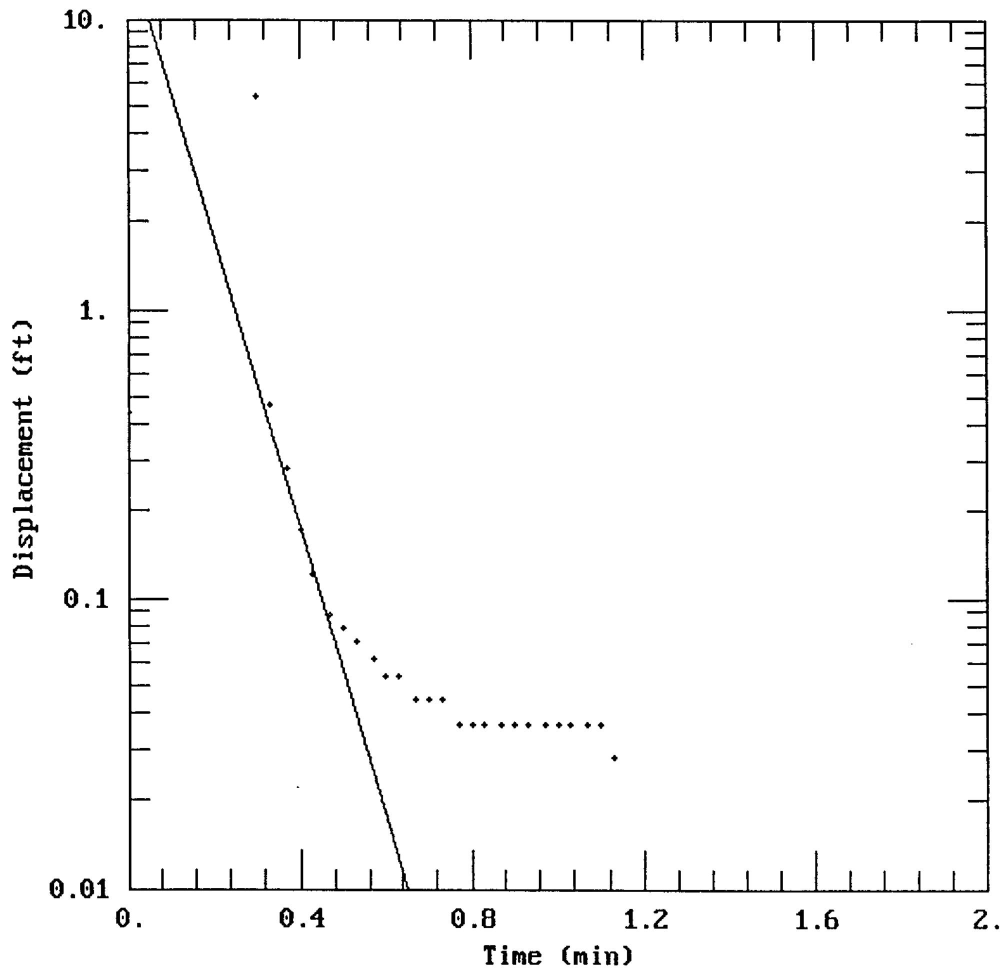
CLIENT: AFCEE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 81 Falling Head Test 1



DATA SET:
W8106I1.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.439 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.1472 ft/min
y0 = 18.23 ft

AQTESOLV

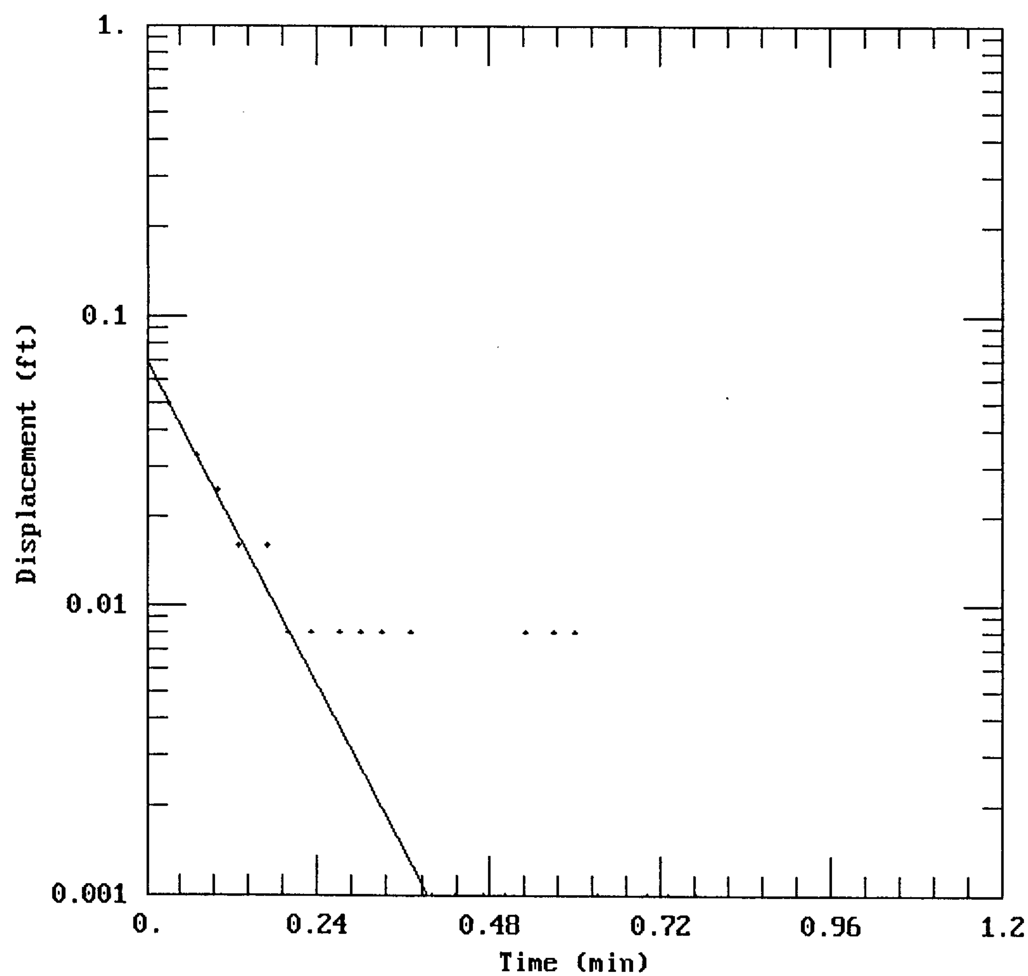
CLIENT: AFCEE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 22 Rising Head Test 2



DATA SET:
W2206R2.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

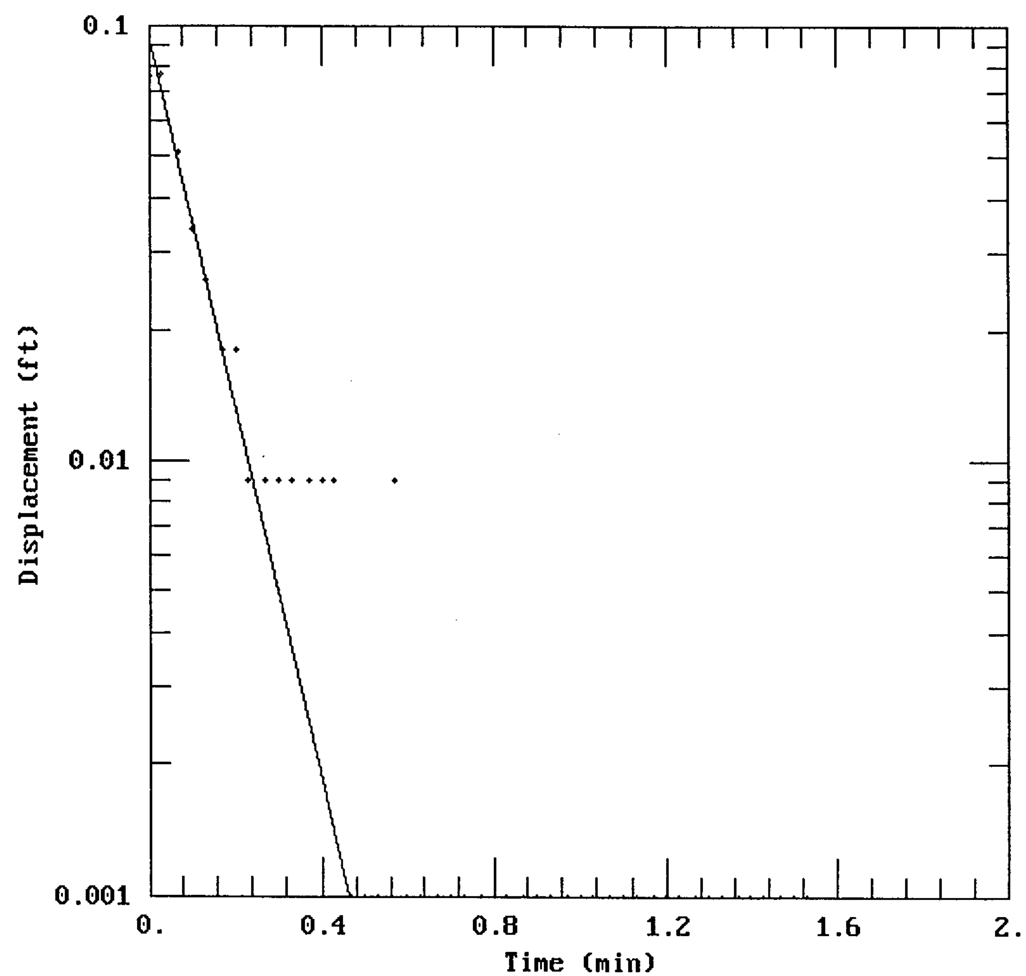
TEST DATA:
H0= 0.05 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.1376 ft/min
y0 = 0.06879 ft

QTESOLV

CLIENT: AFCEE	COMPANY: Parsons E.S.
LOCATION: Columbus AFB, Mississippi	PROJECT: 729691.32050

Well 22 Falling Head Test 2



DATA SET:
W2206F2.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.076 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.1249 ft/min
y0 = 0.09306 ft

AQTESOLV

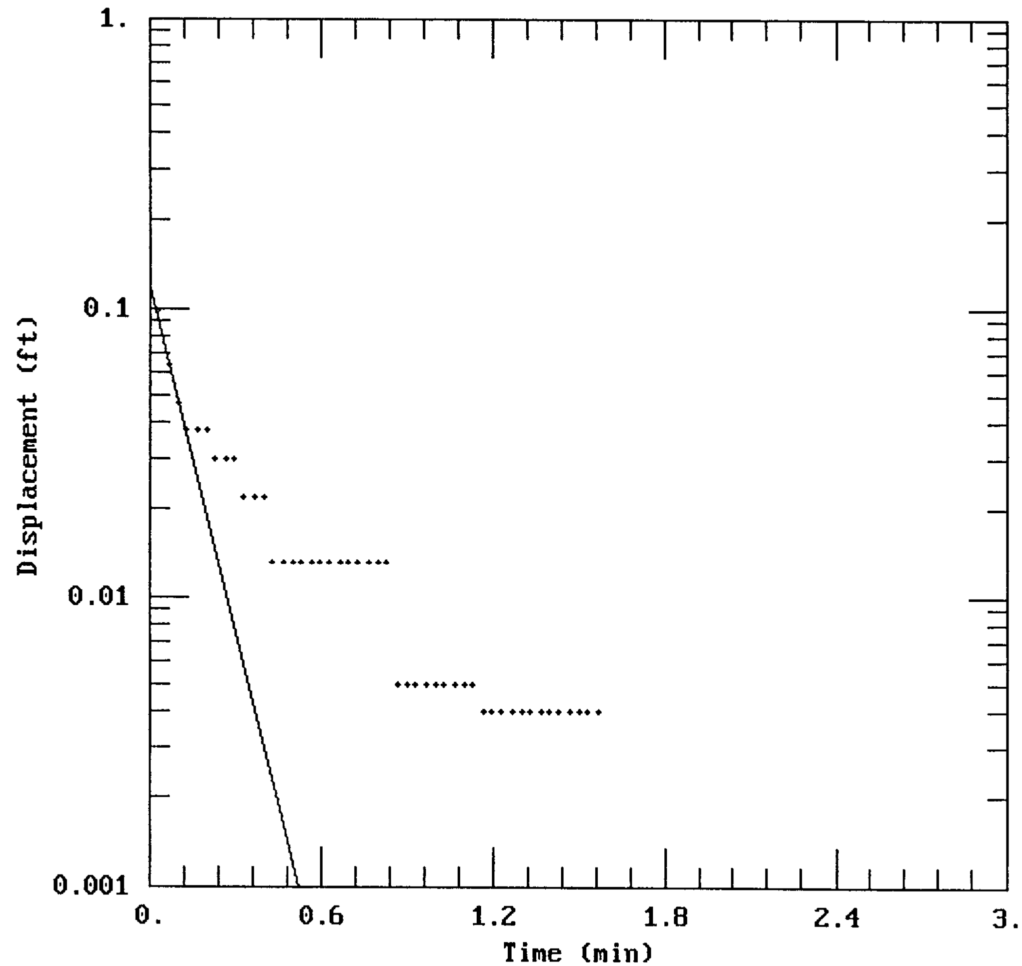
CLIENT: AFCEE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 22 Rising Head Test 1



DATA SET:
W2206R1.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

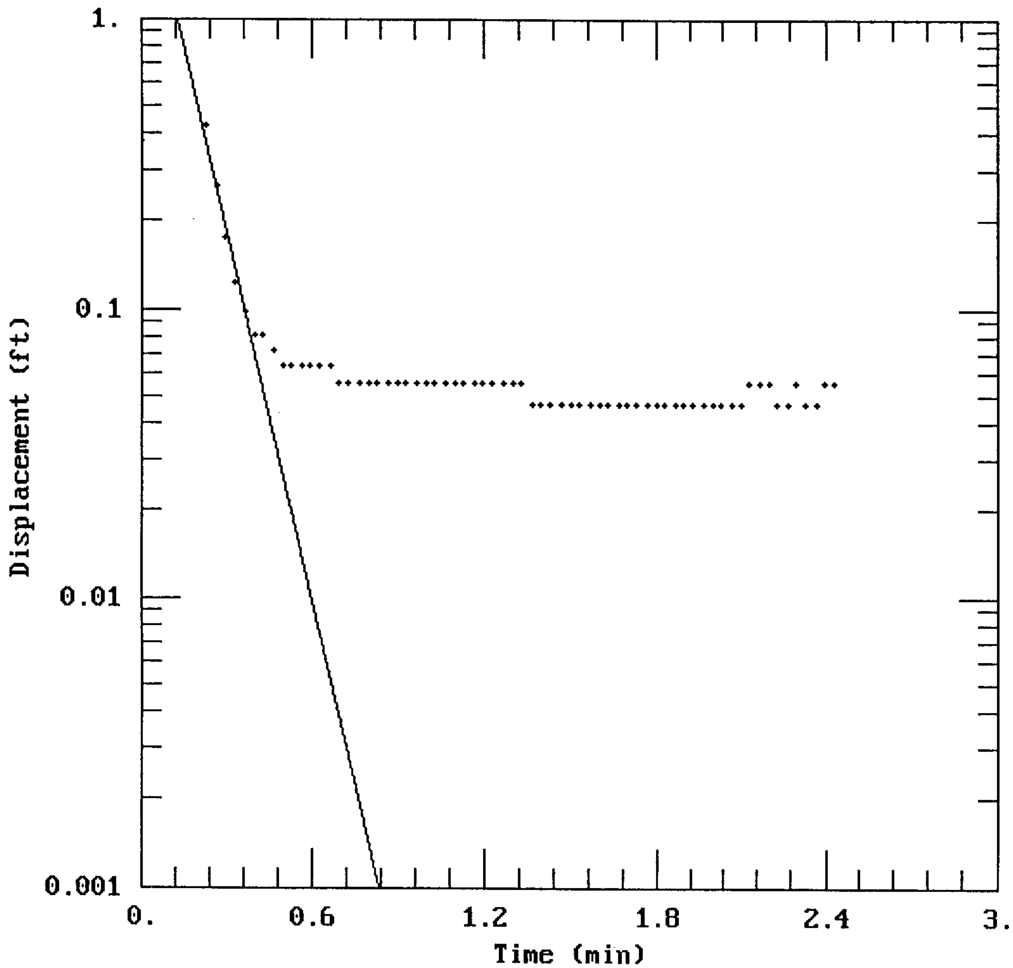
TEST DATA:
H0= 0.1 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.1155 ft/min
y0 = 0.1167 ft

AQTESOLV

CLIENT: AFCEE	COMPANY: Parsons E.S.
LOCATION: Columbus AFB, Mississippi	PROJECT: 729691.32050

Well 22 Falling Head Test 1



DATA SET:
W220611.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

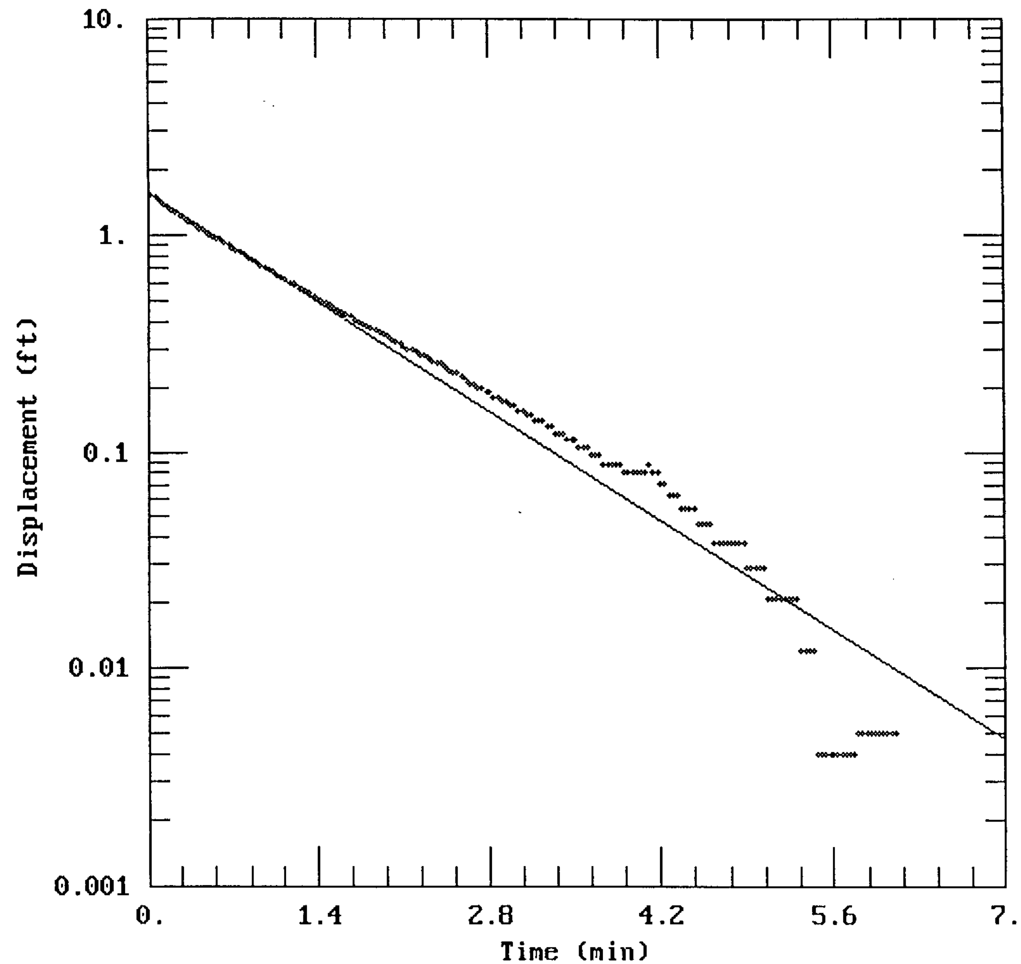
TEST DATA:
H0= 0.38 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.1243 ft/min
y0 = 3.505 ft

AQTESOLV

CLIENT: AFCEE	COMPANY: Parsons E.S.
LOCATION: Columbus AFB, Mississippi	PROJECT: 729691.32050

Well 79 Rising Head Test 2



DATA SET:
W7906R2.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 1.555 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

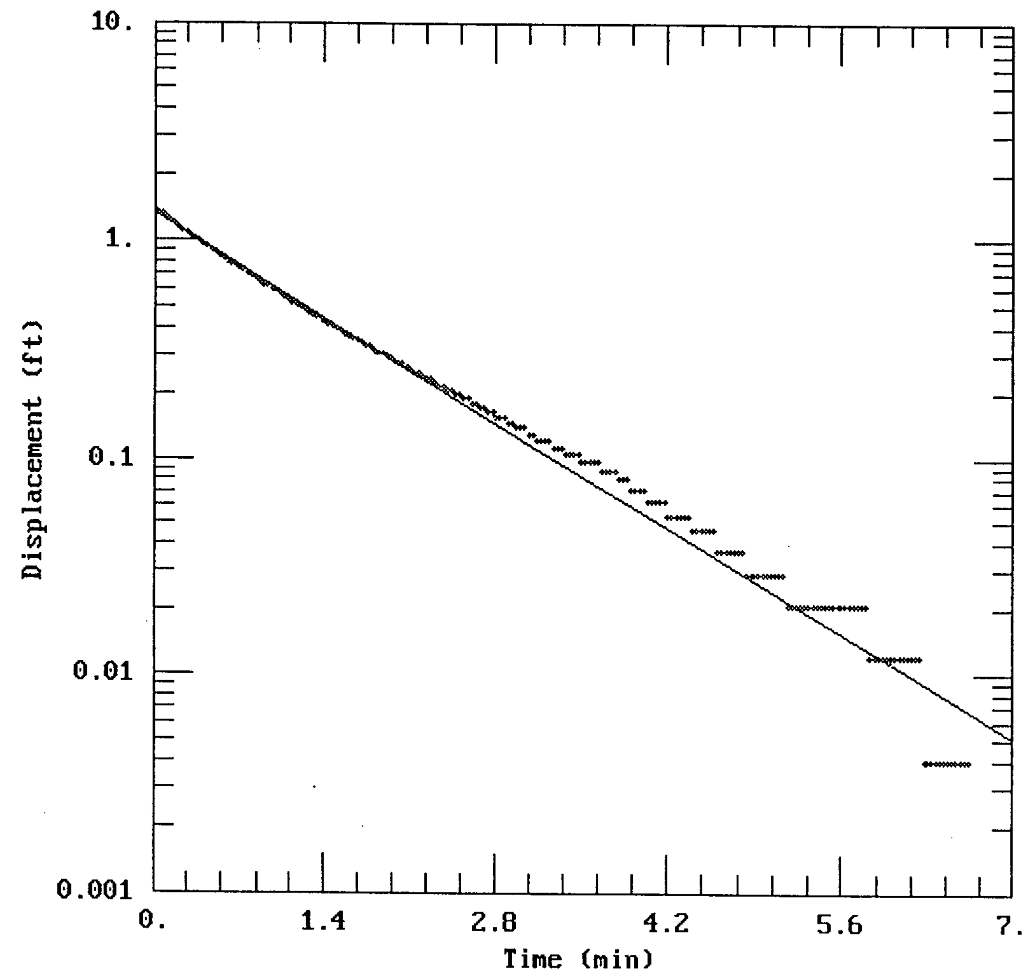
PARAMETER ESTIMATES:
K = 0.01059 ft/min
y0 = 1.562 ft

AQTESOLV

CLIENT: AFCEE | COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi | PROJECT: 729691.32050

Well 79 Falling Head Test 2



DATA SET:
W7906I2.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 1.368 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.01017 ft/min
y0 = 1.343 ft

AQTESOLV

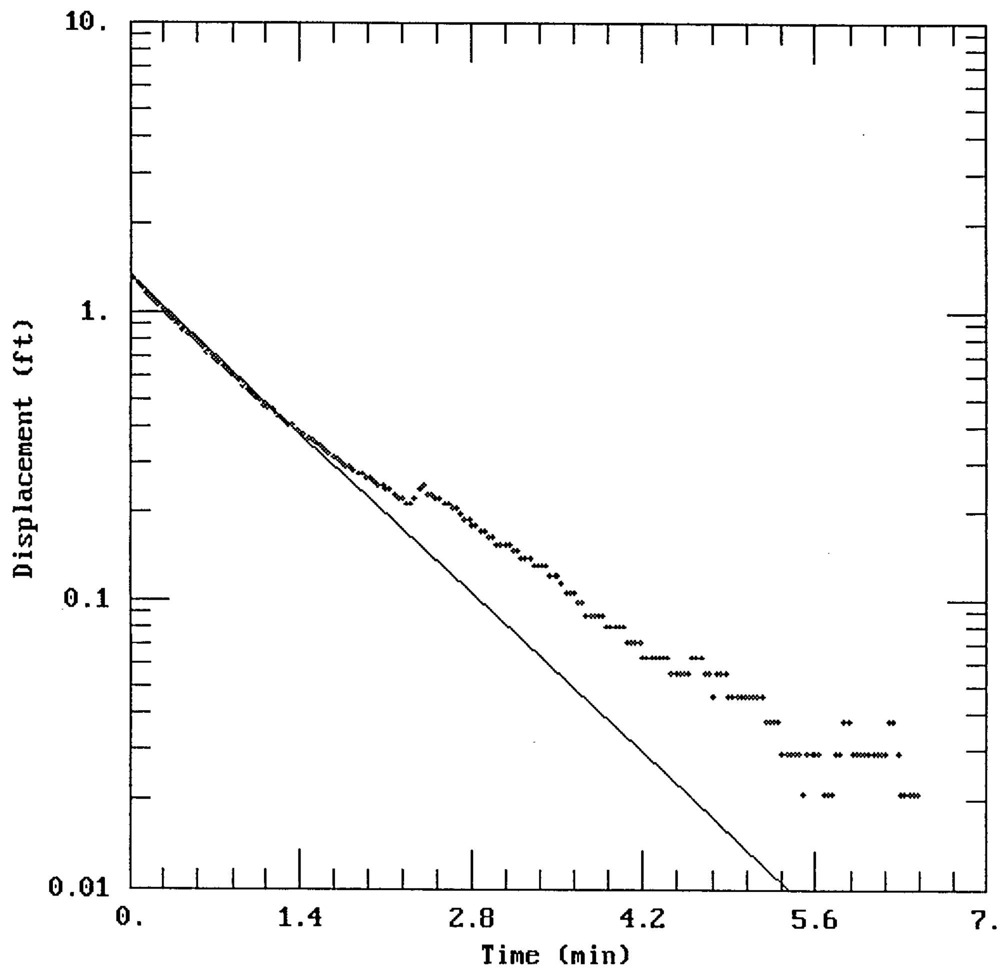
CLIENT: AFCEE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 79 Falling Head Test 1



DATA SET:
W7906I1.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 1.29 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.0116 ft/min
y0 = 1.332 ft

AQTESOLV

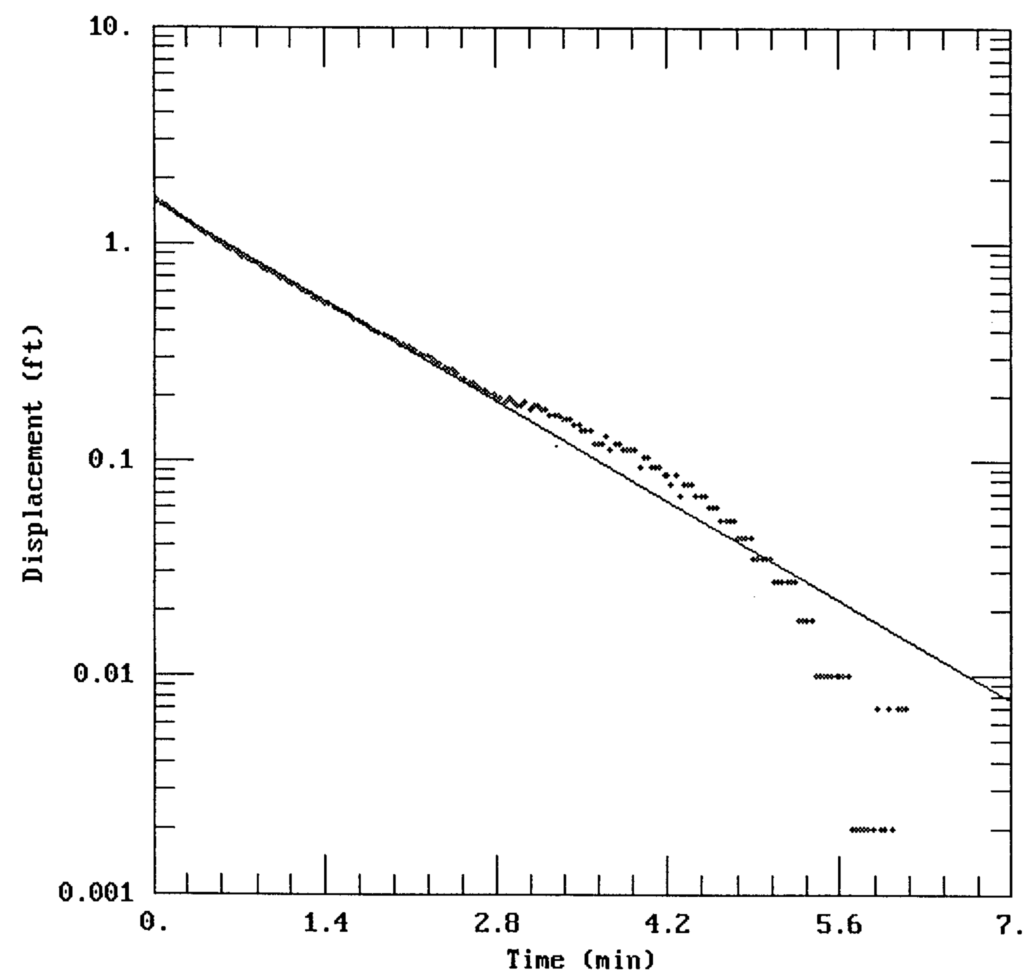
CLIENT: AFCEE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 79 Rising Head Test 1



DATA SET:
W7906R2.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 1.62 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.009694 ft/min
y0 = 1.562 ft

AQTESOLV

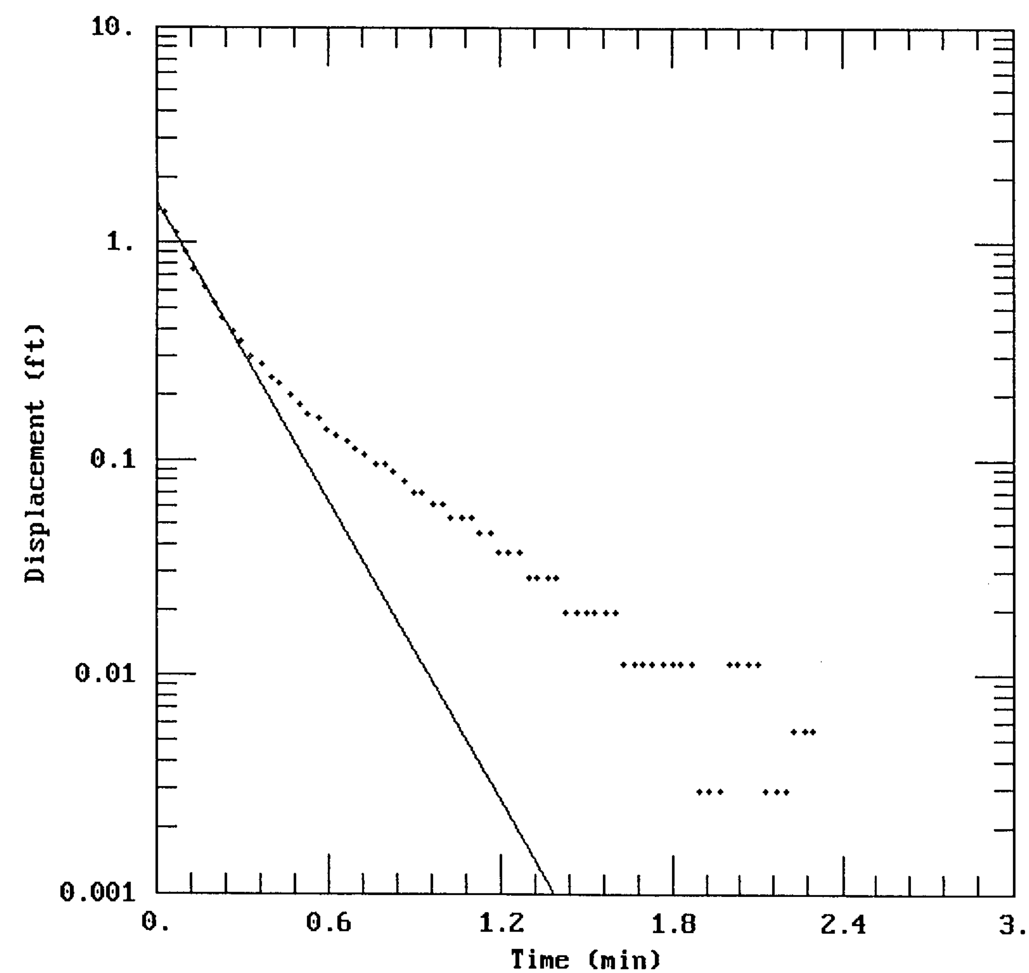
CLIENT: AFCEE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 18 Rising Head Test 1



DATA SET:
W1806R1.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 1.403 ft
r_c = 0.083 ft
r_w = 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.06733 ft/min
y0 = 1.523 ft

AQTESOLV

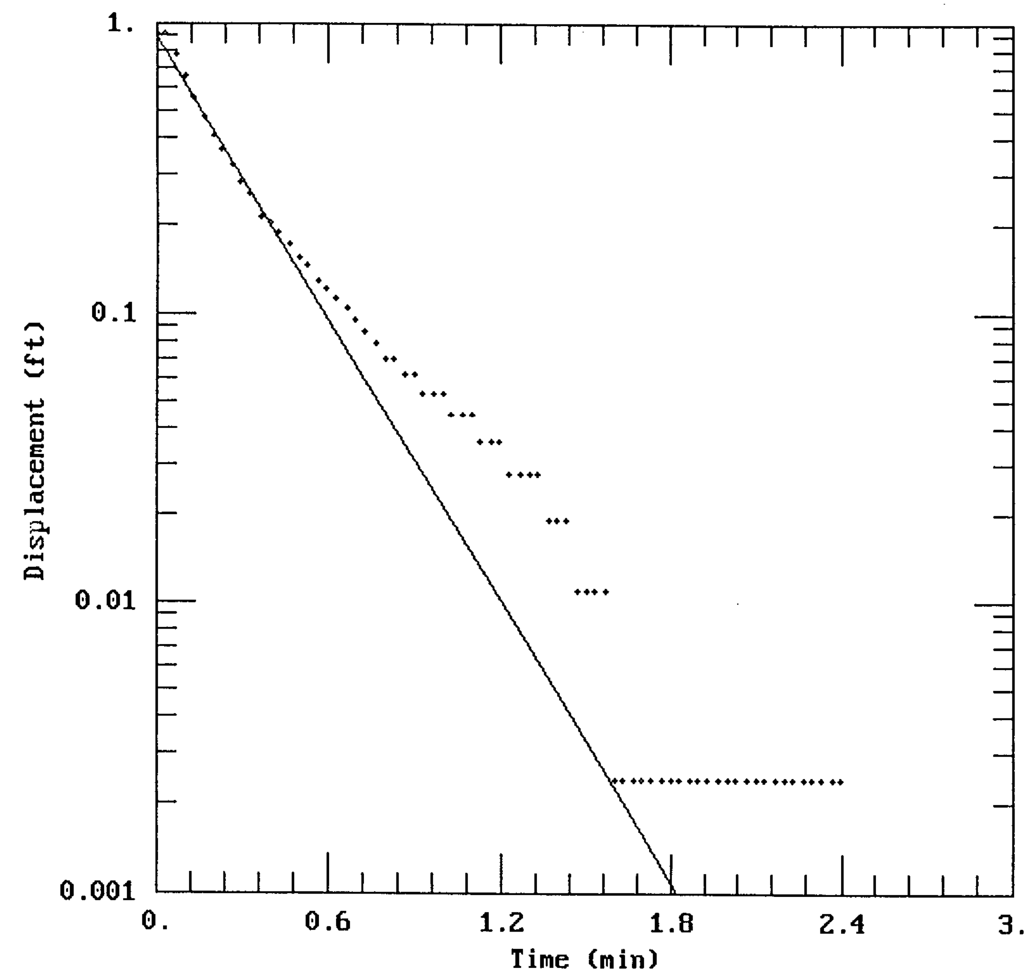
CLIENT: AFCEE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 18 Falling Head Test 1



DATA SET:
W1806I1.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

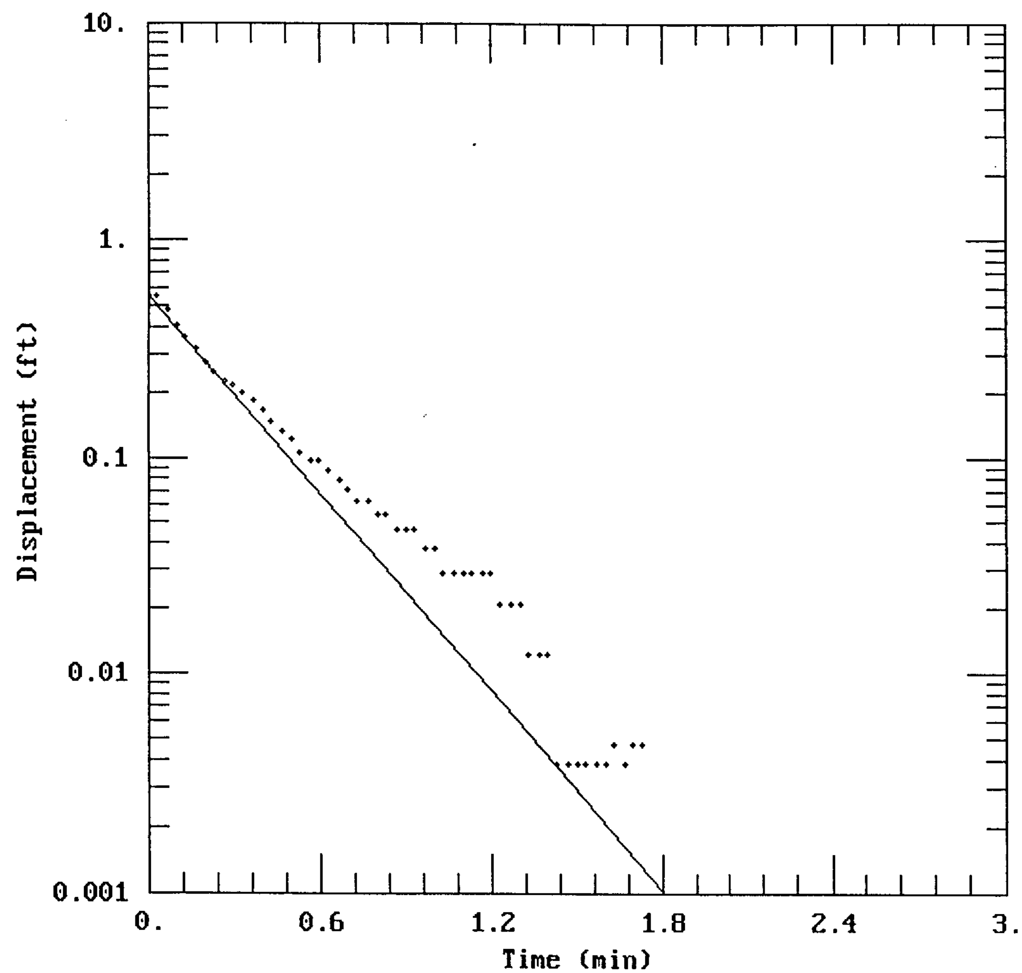
TEST DATA:
H0= 0.921 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.04757 ft/min
y0 = 0.8977 ft

AQTESOLV

CLIENT: AFCEE	COMPANY: Parsons E.S.
LOCATION: Columbus AFB, Mississippi	PROJECT: 729691.32050

Well 18 Rising Head Test 2



DATA SET:
W1806R2.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.558 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.04459 ft/min
y0 = 0.5563 ft

AQTESOLV

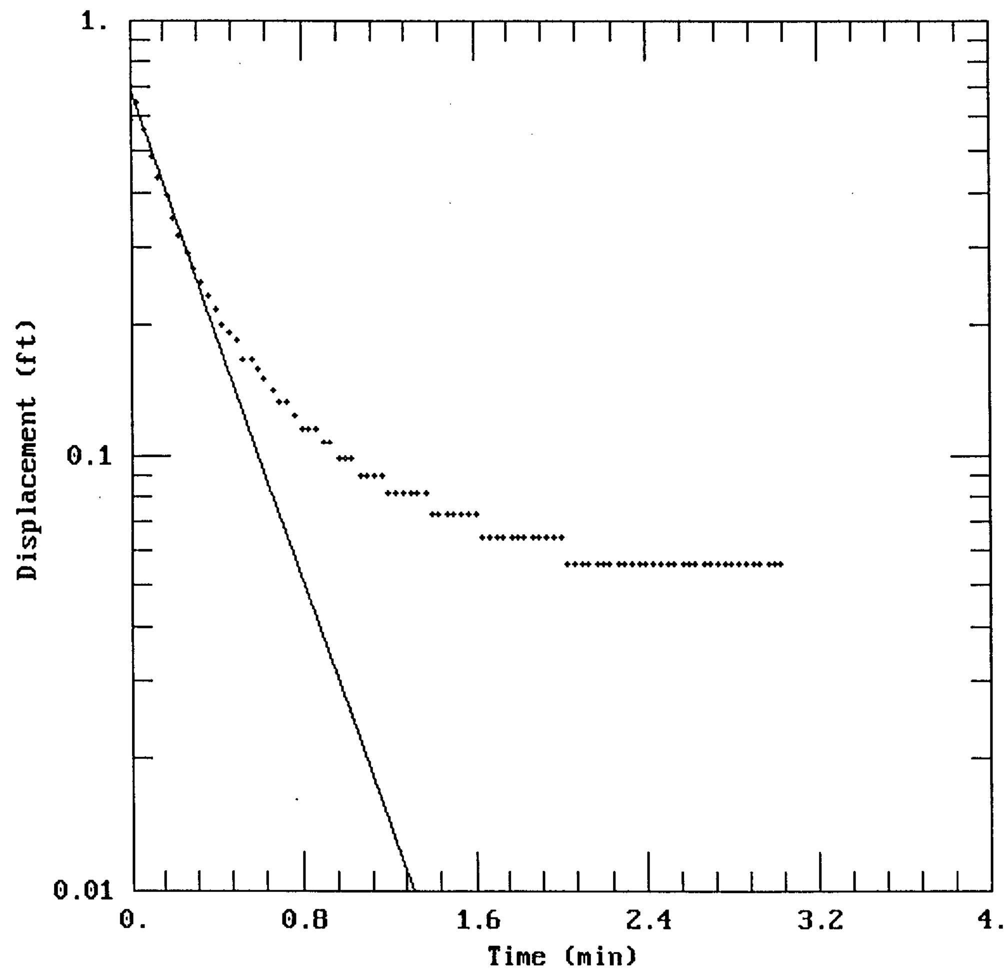
CLIENT: AFCEE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 18 Falling Head Test 2



DATA SET:
W1806I2.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.592 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

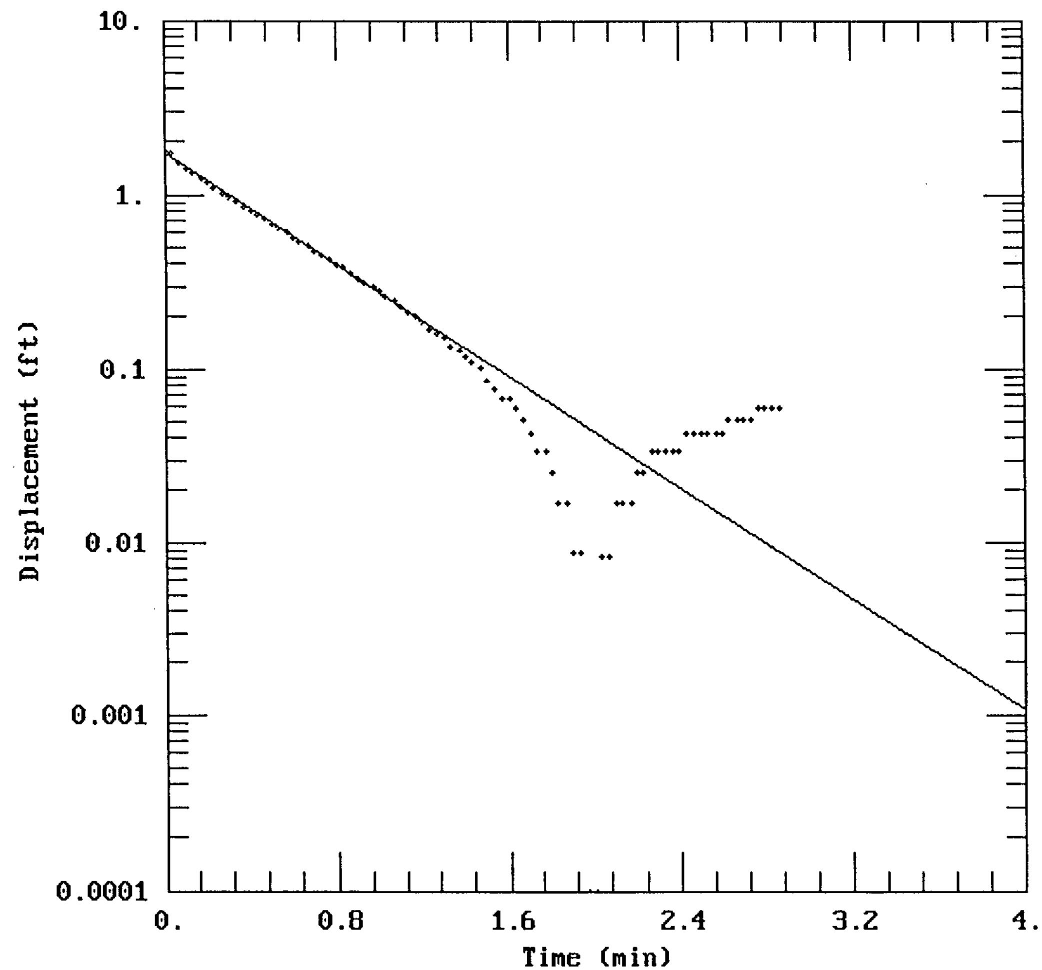
PARAMETER ESTIMATES:
K = 0.04132 ft/min
y0 = 0.6879 ft

AQTESOLV

CLIENT: AFCEE | COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi | PROJECT: 729691.32050

Well 19 Rising Head Test 1



DATA SET:
W1906R1.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

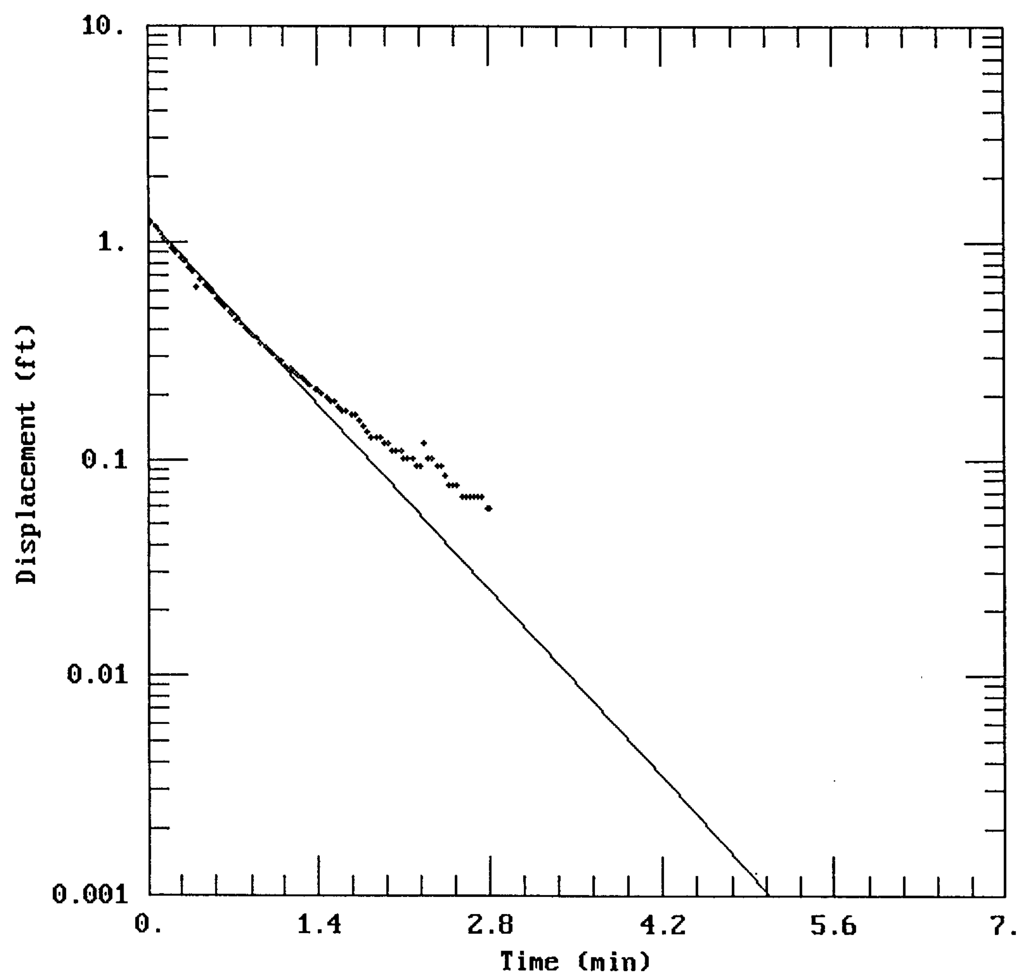
TEST DATA:
H0= 1.774 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.02357 ft/min
y0 = 1.731 ft

AQTESOLV

CLIENT: AFCEE	COMPANY: Parsons E.S.
LOCATION: Columbus AFB, Mississippi	PROJECT: 729691.32050

Well 19 Falling Head Test 1



DATA SET:
W1906I1.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 1.191 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.01799 ft/min
y0 = 1.277 ft

AQTESOLV

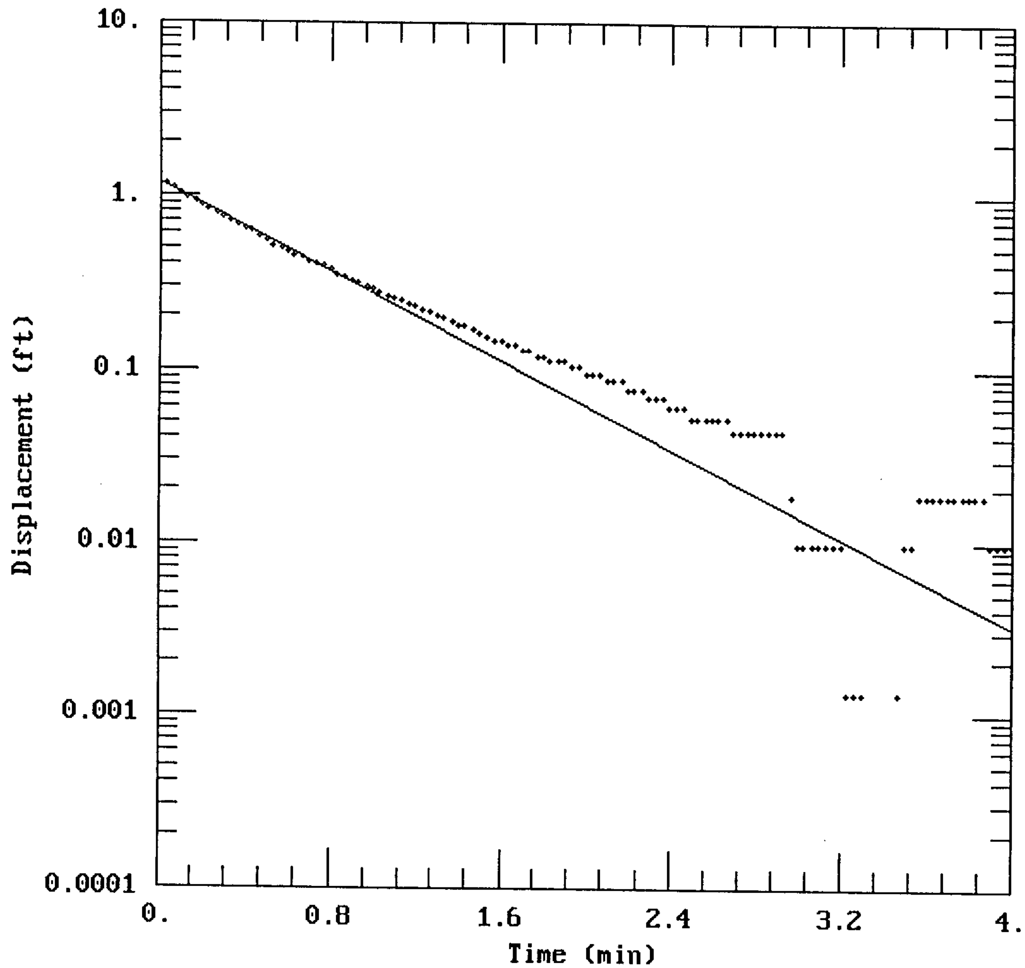
CLIENT: AFCEE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 19 Falling Head Test 2



DATA SET:
W1906I2.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 1.15 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

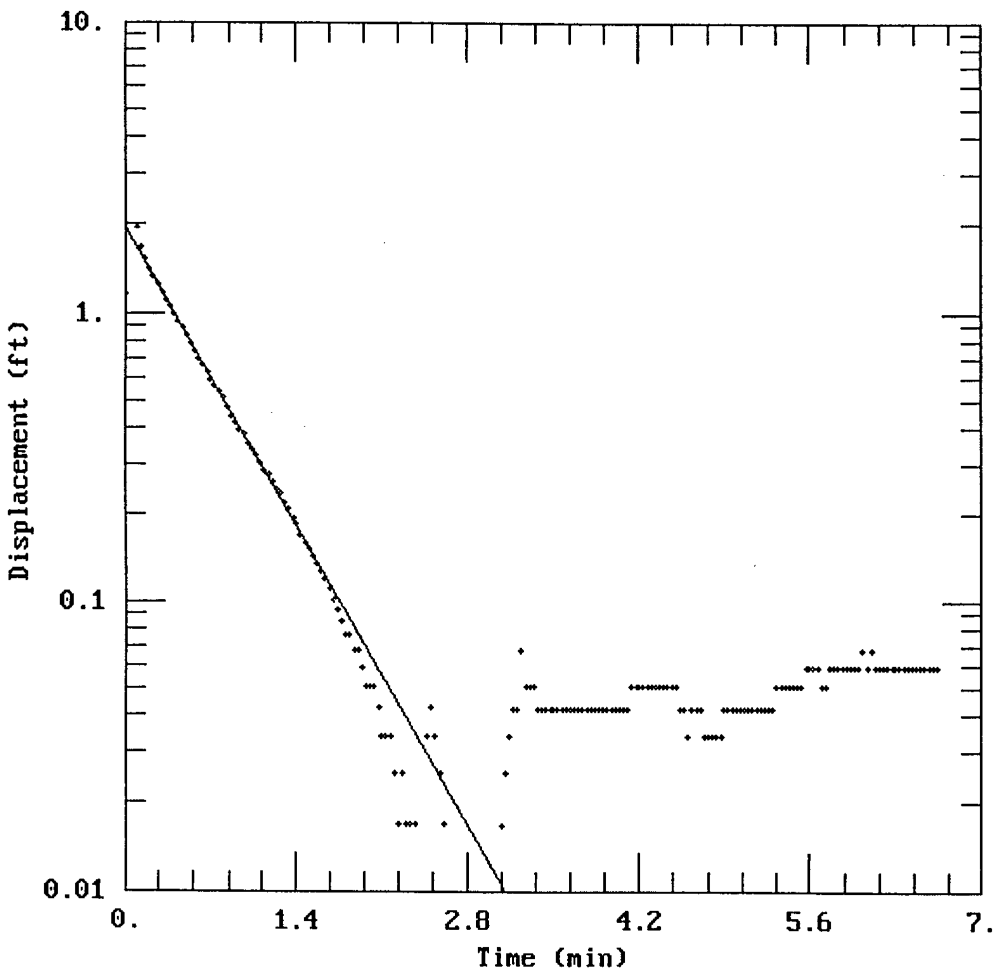
PARAMETER ESTIMATES:
K = 0.01891 ft/min
y0 = 1.186 ft

QTESOLV

CLIENT: AFCEE | COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi | PROJECT: 729691.32050

Well 19 Rising Head Test 2



DATA SET:
W1906R2.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 1.15 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.02164 ft/min
y0 = 1.944 ft

QTESOLV

APPENDIX B

SOIL AND GROUNDWATER ANALYTICAL RESULTS

Evergreen
Analytical
Laboratory

CASE NARRATIVE

Evergreen Analytical Laboratory (EAL) Projects: 96-3990, 96-3996, 96-4004, 96-4020, 96-4033, 96-4047, 96-4058, 96-4064 and 96-4081

Parsons Engineering Science, Inc. (PES) Project: Columbus AFB 729691.32010

Sample Receipt

Soil and groundwater samples were received between November 9 and 19, 1996 from Columbus AFB for analysis under Subcontract 729691.00000. Refer to the check-in portion of the EAL Chain of Custody for specific information regarding the condition of samples upon receipt. Refer to the EAL Work Order Summary for log-in information and cross-reference of EAL and PES sample identifications.

Data Package

All data are reported in one comprehensive package that is segregated based upon EAL project number. Each EAL project represents a group of samples received on a given day. The EAL Work Order Summary lists the samples represented in each EAL project.

A separate invoice for each EAL project number will be generated.

Quality assurance data may overlap from one EAL project to another. All required matrix spike/matrix spike duplicate (MS/MSD) and laboratory control samples (LCS) were analyzed when required and also are included in the data package.

BTEX, Method SW8020/Total Volatile Petroleum Hydrocarbons TVPH, Method SW8015M

All samples were analyzed for BTEX/TVPH within holding time.

Several samples were analyzed at dilutions ranging from a dilution factor of 5 to 200 due to elevated levels of contaminants. The reporting limits have been raised accordingly.

The 1,3,5-trimethylbenzene spike duplicate recovery on sample ST24-MPG was below the EAL acceptance criteria. Reanalysis confirmed matrix effect and non-homogeneous sample.

The 1,2,4-trichlorobenzene surrogate for TVPH analysis could not be separated from the hydrocarbon interference on samples ST24-MPE, ST24-MPD(D) and W3 MS/MSD.

Chlorinated Volatile Organic Compound, VOC's, Method SW8010
All samples were analyzed for chlorinated VOC's within holding time.

Samples LF06-MPF and LF6-MPV were analyzed at a dilution factor of 5 due to elevated levels of contaminants. The reporting limits were raised accordingly. Sample ST24-MPM was analyzed at a dilution factor of 10 to recover the 1-chloro-2-fluoro-benzene surrogate which could not be separated from the hydrocarbon interference at a dilution factor of one.

1,3-dichlorobenzene was indicated on the GC chromatogram for several samples. Mass spectrometer confirmation indicated the compound is 1,4-dichlorobenzene. The GC/MS Quant Reports have been included for your review.

Methane, Method RSKSOP-175M
All samples were analyzed for methane within holding time.

Several samples were analyzed at dilutions ranging from a dilution factor of 5 to 100 due to elevated levels of methane present. The reporting limits were raised accordingly.

Only 2.5 of the required 4 MLs headspace was created in sample W73 due to solids in the sample.

General Chemistry
There are no quality assurance anomalies to report for the following analyses: Anions by Method E300.0, Alkalinity by Method E310.1, Total Organic Carbon in water by Method E415.1 or Total Recoverable Petroleum Hydrocarbons by Method E418.1.

Total Organic Carbon in Soil
Total Organic Carbon (TOC) in soils was analyzed by Huffman Laboratories of Golden Colorado. TOC was determined by analyzing for total carbon (TC) and inorganic (carbonate) carbon (CC), then calculating the difference as TOC. The reports from Huffman are included.

Disk Deliverables
The disk deliverables are included with the hard copy data package. MS/MSD and LCS results are not included on the disk. Please note that blank spaces in the laboratory detection limit and/or practical quantitation limit (PQL) column indicate that there is no detection limit or PQL for that analyte.

Reporting limits have been adjusted to reflect percent moisture in all soil samples or increases due to dilutions.

A hard copy of each spreadsheet from the diskette is included. The name for each spreadsheet is located in the top left corner on the first page of each printout.

Patricia A. McClellan

Patricia A. McClellan, Program Manager
12/6/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF6-MPJ(18')	Client Project No.	: 729691.32010
Lab Sample No.	: 96-3990-02	Lab Project No.	: 96-3990
Date Sampled	: 11/08/96	Matrix	: Soil
Date Received	: 11/09/96	Lab File No.	: HALL1120\008F0101
Date Prepared	: 11/20/96	Method Blank	: RB112096
Date Analyzed	: 11/20/96	Dilution Factor	: 1.2
Percent Moisture	: 15.30		

Compound	CAS #	Concentration(ug/Kg)	RL(ug/Kg)
Vinyl Chloride	75-01-4	U	0.47
Chloroethane	75-00-3	U	0.47
1,1-Dichloroethene	75-35-4	U	0.47
Dichloromethane	75-09-2	U	0.47
trans-1,2-Dichloroethene	156-60-5	U	0.47
1,1-Dichloroethane	75-34-3	U	0.47
cis-1,2-Dichloroethene	156-59-4	U	0.47
1,1,1-Trichloroethane	71-55-6	U	0.47
Carbon Tetrachloride	56-23-5	U	0.47
Trichloroethene	79-01-6	U	0.47
1,1,2-Trichloroethane	79-00-5	U	0.47
Tetrachloroethene	127-18-4	U	0.47
1,1,1,2-Tetrachloroethane	79-00-5	U	0.47
Chlorobenzene	108-90-7	U	0.5
1,1,2,2-Tetrachloroethane	79-34-5	U	0.64
2-Chlorotoluene	95-49-8	U	0.47
[illegible]Chlorotoluene	106-49-8	U	0.47
[illegible],3-Dichlorobenzene	541-73-1	U	0.47
1,2-Dichlorobenzene	95-50-1	U	0.47

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 93% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW3990.XLS; 11/25/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF6-MPL(14-18)	Client Project Number	: 729691.32010
Lab Sample Number	: 96-3996-09	Lab Work Order	: 96-3996
Date Sampled	: 11/9/96	Matrix	: SOIL
Date Received	: 11/11/96	Lab File Number(s)	: TVB11113009
Date Prepared	: 11/13/96	Method Blank	: MB1111396
FID Dilution Factor	: 1.0	Soil Extracted?	: NO
PID Dilution Factor	: 1.0	Soil Moisture	: 14.09%

Compound Name	Cas Number	Analysis Date	Sample* Concentration	RL*	Units
TVH-Gasoline	----	NA	NA	NA	NA
Benzene	71-43-2	11/13/96	U	0.5	ug/kg
Toluene	108-88-3	11/13/96	U	0.5	ug/kg
Chlorobenzene	108-90-7	11/13/96	U	0.5	ug/kg
Ethyl Benzene	100-41-4	11/13/96	U	0.5	ug/kg
Total Xylenes (m,p,o)	1330-20-7	11/13/96	U	0.5	ug/kg
1,3,5-Trimethylbenzene	108-67-8	11/13/96	U	0.5	ug/kg
1,2,4-Trimethylbenzene	95-63-6	11/13/96	U	0.5	ug/kg
1,2,3-Trimethylbenzene	526-73-8	11/13/96	U	0.5	ug/kg
1,2,3,4-Tetramethylbenzene	488-23-3	11/13/96	U	0.6	ug/kg
FID Surrogate Recovery:	NA			50%-150%	(Lin
PID Surrogate Recovery:		94%		50%-150%	(Li

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments: * = Dry Basis

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

[signature] Analyst

K. Hollman
Approved

Evergreen Analytical, Inc.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

EPA 602/8020 Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: LF6-MPL(14-18)	Client Project No.	: 729691.32010
Lab Sample No.	: 96-3996-09	Lab Work Order	: 96-3996
Date Sampled	: 11/9/96	EPA Method No.	: 602/8020
Date Received	: 11/11/96	Matrix	: WATER
Date Prepared	: 11/13/96	Lab File Number(s)	: TVB11113010, 11
Date Analyzed	: 11/13/96	Method Blank	: MB1111396
Instrument Name	: TVHBTEX1	Dilution Factor	: 1.0

Compound	Spike Added (ug/L)	Sample Concentration (ug/L)	Concentration (ug/L) MS	Concentration (ug/L) MSD	Comments
Benzene	20.0	0.0	20.6	21.2	
Toluene	20.0	0.0	19.6	20.3	
Chlorobenzene	20.0	0.0	19.2	19.8	
Ethylbenzene	20.0	0.0	19.7	20.4	
m,p-Xylene	20.0	0.0	19.8	21.3	
o-Xylene	20.0	0.0	19.8	22.1	
1,3,5-TMB	20.0	0.0	19.9	21.1	
1,2,4-TMB	20.0	0.0	19.4	21.5	
1,2,3-TMB	20.0	0.0	19.1	21.0	
1,2,3,4-TeMB	20.0	0.0	18.8	20.2	
Surrogate	100.0	94%	96%	99%	% RECOVERY

Compound		MS % RECOVERY	MSD % RECOVERY	RPD	QC# Limits RPD	QC# Limits %REC
Benzene		103.0	106.0	2.9	18	62 - 129
Toluene		98.0	101.5	3.5	25	55 - 133
Chlorobenzene		96.0	99.0	3.1	9	66 - 122
Ethylbenzene		98.5	102.0	3.5	15	60 - 127
m,p-Xylene		99.0	106.5	7.3	20	44 - 146
o-Xylene		99.0	110.5	11.0	16	57 - 131
1,3,5-TMB		99.5	105.5	5.9	16	63 - 129
1,2,4-TMB		97.0	107.5	10.3	16	55 - 136
1,2,3-TMB		95.5	105.0	9.5	13	64 - 127
1,2,3,4-TeMB		94.0	101.0	7.2	23	53 - 132
Surrogate		96.0	99.0	NA	NA	82 - 115

#= Limits extablished 10/1/96,HDM
*= Values outside of QC limits.

RPD: 0 out of (10) outside limits.
Spike Recovery: 0 out of (20) outside limits.

Comments:

K Hillman
Analyst

McClell
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF6-MPL(14-18)	Client Project No.	: 729691-32010
Lab Sample No.	: 96-3996-09	Lab Project No.	: 96-3996
Date Sampled	: 11/09/96	Matrix	: SOIL
Date Received	: 11/11/96	Lab File No.	: HALL1120\011F0101
Date Prepared	: 11/20/96	Method Blank	: RB112096
Date Analyzed	: 11/20/96	Dilution Factor	: 1.2
Percent Moisture	: 14.09		

Compound	CAS #	Concentration(ug/Kg)	RL(ug/Kg)
Vinyl Chloride	75-01-4	U	0.46
Chloroethane	75-00-3	U	0.46
1,1-Dichloroethene	75-35-4	U	0.46
Dichloromethane	75-09-2	U	0.46
trans-1,2-Dichloroethene	156-60-5	U	0.46
1,1-Dichloroethane	75-34-3	U	0.46
cis-1,2-Dichloroethene	156-59-4	U	0.46
1,1,1-Trichloroethane	71-55-6	U	0.46
Carbon Tetrachloride	56-23-5	U	0.46
Trichloroethene	79-01-6	U	0.46
1,1,2-Trichloroethane	79-00-5	U	0.46
Tetrachloroethene	127-18-4	U	0.46
1,1,1,2-Tetrachloroethane	79-00-5	U	0.46
Chlorobenzene	108-90-7	U	0.46
1,1,2,2-Tetrachloroethane	79-34-5	U	0.49
2-Chlorotoluene	95-49-8	U	0.63
4-Chlorotoluene	106-49-8	U	0.46
1,3-Dichlorobenzene	541-73-1	U	0.46
1,2-Dichlorobenzene	95-50-1	U	0.46

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 90% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW3996.XLS; 11/25/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF6-MPL(14-18)MS	Client Project No.	: 729691-32010
Lab Sample No.	: 96-3996-09MS	Lab Project No.	: 96-3996
Date Sampled	: 11/09/96	Matrix	: SOIL
Date Received	: 11/11/96	Lab File No.	: HALL1120\012F0101
Date Prepared	: 11/20/96	Method Blank	: RB112096
Date Analyzed	: 11/20/96	Dilution Factor	: 1.1
Percent Moisture	: 14.09		

Compound	CAS #	Concentration(ug/Kg)	RL(ug/Kg)
Vinyl Chloride	75-01-4	21	0.46
Chloroethane	75-00-3	22	0.46
1,1-Dichloroethene	75-35-4	23	0.46
Dichloromethane	75-09-2	22	0.46
trans-1,2-Dichloroethene	156-60-5	26	0.46
1,1-Dichloroethane	75-34-3	25	0.46
cis-1,2-Dichloroethene	156-59-4	25	0.46
1,1,1-Trichloroethane	71-55-6	26	0.46
Carbon Tetrachloride	56-23-5	26	0.46
Trichloroethene	79-01-6	26	0.46
1,1,2-Trichloroethane	79-00-5	23	0.46
Tetrachloroethene	127-18-4	25	0.46
1,1,1,2-Tetrachloroethane	79-00-5	23	0.46
Chlorobenzene	108-90-7	25	0.48
1,1,2,2-Tetrachloroethane	79-34-5	19	0.62
2-Chlorotoluene	95-49-8	23	0.46
4-Chlorotoluene	106-49-8	22	0.46
1,3-Dichlorobenzene	541-73-1	24	0.46
1,2-Dichlorobenzene	95-50-1	22	0.46

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 107% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW3996.XLS; 11/25/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF6-MPL(14-18)MSD	Client Project No.	: 729691-32010
Lab Sample No.	: 96-399609MSD	Lab Project No.	: 96-3996
Date Sampled	: 11/09/96	Matrix	: SOIL
Date Received	: 11/11/96	Lab File No.	: HALL1120\013F010
Date Prepared	: 11/20/96	Method Blank	: RB112096
Date Analyzed	: 11/20/96	Dilution Factor	: 1.2
Percent Moisture	: 14.09		

Compound	CAS #	Concentration(ug/Kg)	RL(ug/Kg)
Vinyl Chloride	75-01-4	22	0.47
Chloroethane	75-00-3	22	0.47
1,1-Dichloroethene	75-35-4	23	0.47
Dichloromethane	75-09-2	22	0.47
trans-1,2-Dichloroethene	156-60-5	21	0.47
1,1-Dichloroethane	75-34-3	25	0.47
cis-1,2-Dichloroethene	156-59-4	25	0.47
1,1,1-Trichloroethane	71-55-6	25	0.47
Carbon Tetrachloride	56-23-5	25	0.47
Trichloroethene	79-01-6	26	0.47
1,1,2-Trichloroethane	79-00-5	23	0.47
Tetrachloroethene	127-18-4	25	0.47
1,1,1,2-Tetrachloroethane	79-00-5	22	0.47
Chlorobenzene	108-90-7	24	0.49
1,1,2,2-Tetrachloroethane	79-34-5	20	0.64
2-Chlorotoluene	95-49-8	24	0.47
4-Chlorotoluene	106-49-8	22	0.47
1,3-Dichlorobenzene	541-73-1	21	0.47
1,2-Dichlorobenzene	95-50-1	20	0.47

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 107% 70% - 130% (QC limits)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW3996.XLS; 11/25/96

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Total Recoverable Petroleum Hydrocarbons

Date Sampled : 11/9/96
Date Received : 11/11/96
Date Prepared : 11/13/96
Date Analyzed : 11/13/96

Client Project ID. : 729691-32010
Lab Project Number : 96-3996
Method : EPA 418.1

Evergreen Sample #	Client Sample ID.	Matrix	TRPH	Units
96-3996-09	LF6-MPL (14'-18')	Soil	<3.9	mg/Kg
96-3996-09 Duplicate	LF6-MPL (14'-18') Duplicate	Soil	<3.9	mg/Kg

Method Blank (11/13/96) subtracted 3.4 mg/Kg

Results reported on a dry weight basis.

Analyst

Approved

HUFFMAN
LABORATORIES, INC.
Quality Analytical Services Since 1936
4630 Indiana Street • Golden, CO 80403
Phone: (303) 278-4455 • FAX: (303) 278-7012

CUSTOMER #:
02604

DATE 12/
LAB# 234
P.O. SE
RECD 11/

ANALYSIS REPORT

PATTY MC CLELLEN
EVERGREEN ANALYTICAL, INC
4036 YOUNGFIELD STREET
WHEAT RIDGE CO 80033

P.O. # 013549 & 013550/PROJ 96-3990 & 96-3996

SEQUENCE/ SAMPLE ID	01 LF6-MPJ (18')	02 LF6-MPL (14-18)	03 ST24-MPF(16-18)
CARBONATE C---%	<0.02	<0.02	<0.02
TOTAL CARBON--%	<0.05	<0.05	<0.05
ORGANIC C------%	<0.05	<0.05	<0.05

THE SAMPLES ARE NOT HOMOGENEOUS.

Evergreen Analytical, Inc.

96-4033

WORK ORDER Summary

15-Nov-96

Report To: Dave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Client Project ID: 729691.32010

Phone: (303) 831-8100
FAX: (303) 831-8208

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-4033-01K	ST24-MPD(D)	Anions by IC Cl,NO2,NO3,SO4		Groundwater	D4	13-Nov-96	14-Nov-96	28-Nov-96	15-Nov-96
96-4033-02K	ST24-MPH(S)	Anions by IC Cl,NO2,NO3,SO4						28-Nov-96	15-Nov-96
96-4033-03K	W81	Anions by IC Cl,NO2,NO3,SO4						28-Nov-96	15-Nov-96
96-4033-04K	LF6-MPM	Anions by IC Cl,NO2,NO3,SO4						28-Nov-96	15-Nov-96
96-4033-05K	W22	Anions by IC Cl,NO2,NO3,SO4						28-Nov-96	15-Nov-96
96-4033-06K	W1	Anions by IC Cl,NO2,NO3,SO4						28-Nov-96	15-Nov-96
96-4033-01D	ST24-MPD(D)	BTEX (Parsons List)			2			28-Nov-96	27-Nov-96
96-4033-02D	ST24-MPH(S)	BTEX (Parsons List)						28-Nov-96	27-Nov-96
96-4033-03D	W81	BTEX (Parsons List)						28-Nov-96	27-Nov-96
96-4033-04D	LF6-MPM	BTEX (Parsons List)						28-Nov-96	27-Nov-96
96-4033-05D	W22	BTEX (Parsons List)						28-Nov-96	27-Nov-96
96-4033-06D	W1	BTEX (Parsons List)						28-Nov-96	27-Nov-96
96-4033-07A	Trip Blank	BTEX (Parsons List)		Water	9			28-Nov-96	
96-4033-01H	ST24-MPD(D)	Methane		Groundwater	2	13-Nov-96		28-Nov-96	27-Nov-96
96-4033-02H	ST24-MPH(S)	Methane						28-Nov-96	27-Nov-96
96-4033-03H	W81	Methane						28-Nov-96	27-Nov-96
96-4033-04H	LF6-MPM	Methane						28-Nov-96	27-Nov-96
96-4033-05H	W22	Methane						28-Nov-96	27-Nov-96

# = Special list. See sample comments or test information.
HT = Holding Time expiration date.

pm 11/15/96

Evergreen Analytical, Inc.

96-4033

WORK ORDER Summary

15-Nov-96

Report To: Dave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Client Project ID: 729691.32010

Phone: (303) 831-8100
FAX: (303) 831-8208

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-4033-06H	W1	Methane		Groundwater	2	13-Nov-96	14-Nov-96	28-Nov-96	27-Nov-96
96-4033-01A	ST24-MPD(D)	Purgeable Halocarbons 8010			9			28-Nov-96	27-Nov-96
96-4033-02A	ST24-MPH(S)	Purgeable Halocarbons 8010						28-Nov-96	27-Nov-96
96-4033-03A	W81	Purgeable Halocarbons 8010						28-Nov-96	27-Nov-96
96-4033-04A	LF6-MPM	Purgeable Halocarbons 8010						28-Nov-96	27-Nov-96
96-4033-05A	W22	Purgeable Halocarbons 8010						28-Nov-96	27-Nov-96
96-4033-06A	W1	Purgeable Halocarbons 8010						28-Nov-96	27-Nov-96
96-4033-07A	Trip Blank	Purgeable Halocarbons 8010		Water				28-Nov-96	
96-4033-01K	ST24-MPD(D)	Total Alkalinity		Groundwater	D4	13-Nov-96		28-Nov-96	27-Nov-96
96-4033-02K	ST24-MPH(S)	Total Alkalinity						28-Nov-96	27-Nov-96
96-4033-03L	W81	Total Alkalinity						28-Nov-96	27-Nov-96
96-4033-04L	LF6-MPM	Total Alkalinity						28-Nov-96	27-Nov-96
96-4033-05L	W22	Total Alkalinity						28-Nov-96	27-Nov-96
96-4033-06L	W1	Total Alkalinity						28-Nov-96	27-Nov-96
96-4033-01D	ST24-MPD(D)	TVH (Gasoline)			2			28-Nov-96	27-Nov-96
96-4033-02D	ST24-MPH(S)	TVH (Gasoline)						28-Nov-96	27-Nov-96
96-4033-03D	W81	TVH (Gasoline)						28-Nov-96	27-Nov-96
96-4033-04D	LF6-MPM	TVH (Gasoline)						28-Nov-96	27-Nov-96
96-4033-05D	W22	TVH (Gasoline)						28-Nov-96	27-Nov-96
96-4033-06D	W1	TVH (Gasoline)						28-Nov-96	27-Nov-96
96-4033-07A	Trip Blank	TVH (Gasoline)		Water	9			28-Nov-96	

= [illegible] 'ist. See sample comments or test information.
HT [illegible] .g Time expiration date.

CHAIN OF CUSTODY RECORD / [redacted]ALYTICAL SERVICES REQUEST

1 of 1

Evergre[redacted]nalytical Inc.
4036 Youngfield St.
Wheat Ridge, Colorado 80033
(303) 425-6021
FAX (303) 425-6854
(800) 845-7400

COMPANY [redacted]arsons ES
ADDRESS 1700 Broadway Suite 900
CITY DENVER STATE CO ZIP 80290
PHONE# (303) 831-8100 FAX # (303) 831-8208 FAX RESULTS Y / N
Sampler Name: ROB NAGEL
(signature)
(print) ROB NAGEL

CLIENT CONTACT (print) JEN[redacted] HARTFELDER
CLIENT PROJ. I.D. 729691.32010
EAL. QUOTE # ______ P.O.# 729691.32010
TURNAROUND REQUIRED* ☒ STD (2 wks) ☐ UST
☐ Other (Specify)*
*expedited turnaround subject to additional fee

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	MATRIX: Soil / Solid / Air / Gas	MATRIX: Oil / Sludge / Multi-phase	TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle) 8010	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	PCB Screen	Herbicides 8150/515 (circle)	BTEX 8020/602 (circle)/MTBE (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	Oil & Grease 413.1	TRPH 418.1	Anions (Cl⁻, NO₂, NO₃, SO₄)	METHANE GC404	Alkalinity				For Laboratory use only
ST24-MPD(D)	11/13	0710	12					X						X	X						X	X	X				01A-L
ST24-MPH(S)	11/13	1000	12					X						X	X						X	X	X				02A-L
W81	11/13	1445	12					X						X	X						X	X	X				03A-L
IF6-MPM	11/13	1630	12					X						X	X						X	X	X				04A-L
W22	11/13	1750	12					X						X	X						X	X	X				05A-L
W1	~~11/13~~ 11/13	1830	12					X						X	X						X	X	X				06A-L
Trip Blank	—			~~[illegible]~~				~~X~~						~~X~~	~~X~~												~~[illegible]~~ 07A
Sample Fraction								AC						D6	D6						K	HJ	L				Loc 2,11,[illegible]
Instructions:				Container																							

For Laboratory use only:
W.O. # 96-4033
B.O.F. # NA
C/S (O) 81 / Co
C/S (I) 81 / LD
Cooler Temp. °C 2
Seals Intact Y / N / NA
Samples Pres Y / N / NA
Headspace Y / N / NA
By [illegible] /

OIL + O2L not received. PK.

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
Rob Nagel	11/13/96 1700	[illegible] Black	11/19/96 09:00				

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: W81	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4033-03	Lab Work Order	: 96-4033
Date Sampled	: 11/13/96	Matrix	: WATER
Date Received	: 11/14/96	Lab File Number(s)	: TVB31115012
Date Prepared	: 11/15/96	Method Blank	: MB3111596
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/15/96	U	0.1	mg/L
Benzene	71-43-2	11/15/96	0.9	0.4	ug/L
Toluene	108-88-3	11/15/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/15/96	10	0.4	ug/L
Ethyl Benzene	100-41-4	11/15/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/15/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/15/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/15/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/15/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/15/96	1.3	0.5	ug/L
FID Surrogate Recovery:		96%		70%-126%	(Li
PID Surrogate Recovery:		93%		76%-127%	(L

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Blecha
Analyst

K. Hellman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF6-MPM	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4033-04	Lab Work Order	: 96-4033
Date Sampled	: 11/13/96	Matrix	: WATER
Date Received	: 11/14/96	Lab File Number(s)	: TVB31115017
Date Prepared	: 11/15/96	Method Blank	: MB3111596
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/15/96	U	0.1	mg/L
Benzene	71-43-2	11/15/96	U	0.4	ug/L
Toluene	108-88-3	11/15/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/15/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/15/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/15/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/15/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/15/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/15/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/15/96	U	0.5	ug/L
Surrogate Recovery:		90%		70%-126%	(Limits)
Surrogate Recovery:		88%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. [illegible] — Analyst

K. Hollman — Approved

EVERGREEN ANALYTICAL, INC.
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(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	:	W22	Client Project Number	:	729691.32010
Lab Sample Number	:	96-4033-05	Lab Work Order	:	96-4033
Date Sampled	:	11/13/96	Matrix	:	WATER
Date Received	:	11/14/96	Lab File Number(s)	:	TVB31115018
Date Prepared	:	11/15/96	Method Blank	:	MB3111596
FID Dilution Factor	:	1.0			
PID Dilution Factor	:	1.0			

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/15/96	U	0.1	mg/L
Benzene	71-43-2	11/15/96	U	0.4	ug/L
Toluene	108-88-3	11/15/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/15/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/15/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/15/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/15/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/15/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/15/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/15/96	U	0.5	ug/L
FID Surrogate Recovery:		88%		70%-126%	(Li
PID Surrogate Recovery:		85%		76%-127%	(Li

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Blecha
Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
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(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: W1	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4033-06	Lab Work Order	: 96-4033
Date Sampled	: 11/13/96	Matrix	: WATER
Date Received	: 11/14/96	Lab File Number(s)	: TVB31115019
Date Prepared	: 11/15/96	Method Blank	: MB3111596
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/15/96	U	0.1	mg/L
Benzene	71-43-2	11/15/96	U	0.4	ug/L
Toluene	108-88-3	11/15/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/15/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/15/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/15/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/15/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/15/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/15/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/15/96	U	0.5	ug/L
[illegible]D Surrogate Recovery:		90%		70%-126%	(Limits)
[illegible] Surrogate Recovery:		86%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Blecha
Analyst

K. Hollman
Approved

TVBXWS2P;TV24081P.XLS; 11/21/96; 7

EVERGREEN ANALYTICAL, INC.
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(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report
Method Blank Report

Method Blank Number	: MB3111596	Client Project Number	: 729691.32010
Date Prepared	: 11/15/96	Lab Work Order	: 96-4033
Dilution Factor	: 1.0	Matrix	: WATER
		Lab File Number	: TVB31115009

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/15/96	U	0.1	mg/L
Benzene	71-43-2	11/15/96	U	0.4	ug/L
Toluene	108-88-3	11/15/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/15/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/15/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/15/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/15/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/15/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/15/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/15/96	U	0.5	ug/L
FID Surrogate Recovery:		96%		70%-126%	(Lir
PID Surrogate Recovery:		93%		76%-127%	(L

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Blecha
Analyst

K. Hollman
Approved

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Methods 602/8020 and 5030/8015 Modified Data Report
Method Blank Report

Method Blank Number	: MB3111696	Client Project Number	: 729691.32010
Date Prepared	: 11/16/96	Lab Work Order	: 96-4033
Dilution Factor	: 1.0	Matrix	: WATER
		Lab File Number	: TVB31115027

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/16/96	U	0.1	mg/L
Benzene	71-43-2	11/16/96	U	0.4	ug/L
Toluene	108-88-3	11/16/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/16/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/16/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/16/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/16/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/16/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/16/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/16/96	U	0.5	ug/L
ID Surrogate Recovery:		93%		70%-126%	(Limits)
Surrogate Recovery:		91%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

Analyst

K. Hollman
Approved

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Methods 602/8020 and 5030/8015 Modified Data Report
Method Blank Report

Method Blank Number	: MB2111896	Client Project Number	: 729691.32010
Date Prepared	: 11/18/96	Lab Work Order	: 96-4033
Dilution Factor	: 1.0	Matrix	: WATER
		Lab File Number	: TVB21118003

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/18/96	U	0.1	mg/L
Benzene	71-43-2	11/18/96	U	0.4	ug/L
Toluene	108-88-3	11/18/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/18/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/18/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/18/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/18/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/18/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/18/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/18/96	U	0.5	ug/L
FID Surrogate Recovery:		92%		70%-126%	(Li
PID Surrogate Recovery:		97%		76%-127%	(

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:
E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

K. Hollman
Analyst

P. McClellan
Approved

EVERGREEN ANALYTICAL, INC.
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Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	:	TRIP BLANK	Client Project Number	:	729691.32010
Lab Sample Number	:	96-4033-07	Lab Work Order	:	96-4033
Date Sampled	:	N/A	Matrix	:	WATER
Date Received	:	11/14/96	Lab File Number(s)	:	TVB21118036
Date Prepared	:	11/18/96	Method Blank	:	MB2111896
FID Dilution Factor	:	1.0			
PID Dilution Factor	:	1.0			

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/18/96	U	0.1	mg/L
Benzene	71-43-2	11/18/96	U	0.4	ug/L
Toluene	108-88-3	11/18/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/18/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/18/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/18/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/18/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/18/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/18/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/18/96	U	0.5	ug/L
Surrogate Recovery:		94%		70%-126%	(Limits)
Surrogate Recovery:		94%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA =Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Blecha
Analyst

K. Hollman
Approved

Evergreen Analytical, Inc.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
TVH Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: W81	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4033-03	Lab Work Order	: 96-4033
Date Sampled	: 11/13/96	EPA Method No.	: 5030/8015 Modified
Date Received	: 11/14/96	Matrix	: WATER
Date Prepared	: 11/15/96	Lab File Number(s)	: TVB31115013,14
Date Analyzed	: 11/15/96	Method Blank	: MB3111596
Instrument Name	: TVHBTEX3	Dilution Factor	: 1.0

Compound	Spike Added (mg/L)	Sample Concentration (mg/L)	MS Concentration (mg/L)	MS %REC	QC (#) Limits %REC
Gasoline	2.00	0.00	1.80	89.9%	55 - 128
Surrogate **	---	---	---	97%	70 - 130

Compound	Spike Added (mg/L)	MSD Concentration (mg/L)	MSD %REC	RPD	QC Limits RPD	QC Limits %REC
Gasoline	2.00	1.72	86.2%	4.3	50	50 - 150
Surrogate **	---	---	94%	NA	NA	70 - 130

RPD: 0 out of (1) outside limits.
Spike Recovery: 0 out of (2) outside limits.

Notes:
NA = Not analyzed/not applicable.
* = Values outside of QC limits.
** = 1,2,4-Trichlorobenzene

Comments:

M. Blecha
Analyst

K. Hellman
Approved

Evergreen Analytical, Inc.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

EPA 602/8020 Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: W81	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4033-03	Lab Work Order	: 96-4033
Date Sampled	: 11/13/96	EPA Method No.	: 602/8020
Date Received	: 11/14/96	Matrix	: WATER
Date Prepared	: 11/15/96	Lab File Number(s)	: TVB31115015,16
Date Analyzed	: 11/15/96	Method Blank	: MB3111596
Instrument Name	: TVHBTEX3	Dilution Factor	: 1.0

Compound	Spike Added (ug/L)	Sample Concentration (ug/L)	Concentration (ug/L) MS	Concentration (ug/L) MSD	Comments
Benzene	20.0	0.9	18.5	18.8	
Toluene	20.0	0.0	16.8	17.3	
Chlorobenzene	20.0	10.0	27.2	27.8	
Ethylbenzene	20.0	0.0	17.1	17.6	
m,p-Xylene	20.0	0.0	17.4	17.7	
o-Xylene	20.0	0.0	16.8	17.4	
1,3,5-TMB	20.0	0.0	17.8	19.5	
1,2,4-TMB	20.0	0.0	16.7	17.2	
1,2,3-TMB	20.0	0.0	17.7	18.5	
1,2,3,4-TeMB	20.0	1.3	17.3	18.3	
Surrogate	100.0	93%	93%	92%	

Compound	MS % RECOVERY	MSD % RECOVERY	RPD	QC Limits RPD	QC Limits %REC
Benzene	88.0	89.5	1.7	25	39 - 150
Toluene	84.0	86.5	2.9	25	46 - 148
Chlorobenzene	86.0	89.0	3.4	25	55 - 135
Ethylbenzene	85.5	88.0	2.9	25	32 - 160
m,p-Xylene	87.0	88.5	1.7	25	25 - 150
o-Xylene	84.0	87.0	3.5	25	25 - 150
1,3,5-TMB	89.0	97.5	9.1	25	25 - 150
1,2,4-TMB	83.5	86.0	2.9	25	25 - 150
1,2,3-TMB	88.5	92.5	4.4	25	25 - 150
1,2,3,4-TeMB	80.0	85.0	6.1	25	25 - 150
Surrogate	93.0	92.0	NA	NA	70 - 130

* = Values outside of QC limits.

RPD: 0 out of (10) outside limits.
Spike Recovery: 0 out of (20) outside limits.

Comments: ______

M. Blecha
Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
Laboratory Control Sample (LCS)

LCS Number	: LCS3111596-GAS	Matrix	: WATER
Date Prepared	: 11/15/96	Method Numbers	: EPA 5030/8015 Modified
Date Analyzed	: 11/15/96	Instrument Name	: TVHBTEX3
Lab File Number(s)	: TVB31115007		

Compound Name	Theoretical Concentration (mg/L)	LCS Concentration (mg/L)	LCS % Recovery	QC Limit % Recovery
Gasoline	2.00	1.98	99.2	50 - 150
Surrogate Recovery:		105%		70 - 130

QUALIFIERS

B = TVH as Gasoline found in blank also.
E = Extrapolated value. Value exceeds calibration range.
NA = Not Available/Not Applicable.

M. Klecha
Analyst

K Hollman
Approved

LCSTVH3;LCS31115.XLS; 11:48 AM; 11/19/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St.
Wheat Ridge, CO 80033
(303) 425-6021

EPA 602/8020 Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS3111596-BTEX	Dilution Factor	: 1.00
Date Extracted/Prepared	: 11/15/96	Method	: 602/8020
Date Analyzed	: 11/15/96	Matrix	: Water
Spike Amount (ug/L)	: 20.0	Lab File No.	: TVB31115008

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit % Recovery
Benzene	71-43-2	18.5	92.5	50 - 150
Toluene	108-88-3	18.2	91.0	50 - 150
Chlorobenzene	108-90-7	16.8	84.0	50 - 150
Ethyl Benzene	100-41-4	18.3	91.5	50 - 150
m,p-Xylene	108-38-3 106-42-3	36.0	90.0	50 - 150
[illegible]ylene	95-47-6	18.2	91.0	50 - 150
M[illegible]	1634-04-4	18.6	93.0	50 - 150
1,3,5-Trimethylbenzene	108-67-8	18.9	94.5	50 - 150
1,2,4-Trimethylbenzene	95-63-6	17.5	87.5	50 - 150
1,2,3-Trimethylbenzene	526-73-8	21.1	105.5	50 - 150
1,2,3,4-Tetramethylbenzene	488-23-3	18.8	94.0	50 - 150
Surrogate Recovery:		96%		70 - 130

NOTES: m,p-xylene = 40.0 ppb spike.

QUALIFIERS:
E = Extrapolated value. Value exceeds that of the calibration range.
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
NA = Not available/Not analyzed.

M. Bleha
Analyst

K Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
Laboratory Control Sample (LCS)

LCS Number	: LCS2111896-GAS	Matrix	: WATER
Date Prepared	: 11/18/96	Method Numbers	: EPA 5030/8015 Modified
Date Analyzed	: 11/18/96	Instrument Name	: TVHBTEX2
Lab File Number(s)	: TVB21118013		

Compound Name	Theoretical Concentration (mg/L)	LCS Concentration (mg/L)	LCS % Recovery	QC Limit % Recovery
Gasoline	2.00	2.32	115.9	81 - 128
Surrogate Recovery:		125%		70 - 126

QUALIFIERS

B = TVH as Gasoline found in blank also.
E = Extrapolated value. Value exceeds calibration range.
NA=Not Available/Not Applicable.
** = Limits established 10/1/96 for TVHBTEX2. MAB

M. Blecha
Analyst

K. Hollman
Approved

LCSTVH2;LSB21118.XLS; 10:16 AM; 11/20/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St.
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(303) 425-6021

EPA 602/8020 Data Report
Laboratory Control Sample (LCS)

LCS Number	:	LCS2111896-BTEX	Dilution Factor	:	1.00
Date Extracted/Prepared	:	11/18/96	Method	:	602/8020
Date Analyzed	:	11/18/96	Matrix	:	Water
Spike Amount (ug/L)	:	20.0	Lab File No.	:	TVB221118014

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit** % Recovery
Benzene	71-43-2	20.6	103.0	75 - 116
Toluene	108-88-3	20.0	100.0	75 - 118
Chlorobenzene	108-90-7	18.2	91.0	73 - 115
Ethyl Benzene	100-41-4	19.7	98.5	80 - 122
m,p-Xylene	108-38-3 106-42-3	38.1	95.3	76 - 120
Xylene	95-47-6	20.0	100.0	76 - 118
	1634-04-4	20.5	102.5	75 - 115
1,3,5-Trimethylbenzene	108-67-8	19.6	98.0	64 - 118
1,2,4-Trimethylbenzene	95-63-6	18.1	90.5	75 - 111
1,2,3-Trimethylbenzene	526-73-8	22.6	113.0	82 - 127
1,2,3,4-Tetramethylbenzene	488-23-3	20.6	103.0	72 - 131
Surrogate Recovery:		100%		76 - 127

NOTES: m,p-xylene = 40.0 ppb spike.

QUALIFIERS:
E = Extrapolated value. Value exceeds that of the calibration range.
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
NA = Not available/Not analyzed.
= Limits established 10/1/96 for TVHBTEX2. MAB

M. Bleak
Analyst

K. Hollman
Approved

LCSBXWS2:LSP21118.XLS: 11/20/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 8010 Chlorinated VOC's Method Blank Report

Method Blank	: RB112196	Client Project No.	: 729691.32010
Date Prepared	: 11/21/96	Lab Project No.	: 96-4033
Date Analyzed	: 11/21/96	Lab File No.	: HALL1121\004F0101

Compound	CAS #	Concentration (ug/L)	RL(ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	
1,3-Dichlorobenzene	541-73-1	U	
1,2-Dichlorobenzene	95-50-1	U	

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 81% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4033.XLS; 11/26/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Method Blank Report

Method Blank	: RB112596	Client Project No.	: 729691.32010
Date Prepared	: 11/25/96	Lab Project No.	: 96-4033
Date Analyzed	: 11/25/96	Lab File No.	: HALL1125\004F0101

Compound	CAS #	Concentration (ug/L)	RL(ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 85% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4033.XLS; 11/26/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	:	W81	Client Project No.	:	729691.32010
Lab Sample No.	:	96-4033-03	Lab Project No.	:	96-4033
Date Sampled	:	11/13/96	Matrix	:	Water
Date Received	:	11/14/96	Lab File No.	:	HALL1125\005F0101
Date Prepared	:	11/25/96	Method Blank	:	RB112596
Date Analyzed	:	11/25/96	Dilution Factor	:	1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	4.8	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	6.5	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	0.49 J	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 94% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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HLW4033.XLS; 11/26/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF6-MPM	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4033-04	Lab Project No.	: 96-4033
Date Sampled	: 11/13/96	Matrix	: Water
Date Received	: 11/14/96	Lab File No.	: HALL1121\020F0101
Date Prepared	: 11/21/96	Method Blank	: RB112196
Date Analyzed	: 11/21/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	2.7	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	3.8	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	1.1	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 82% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4033.XLS; 11/26/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: W22	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4033-05	Lab Project No.	: 96-4033
Date Sampled	: 11/13/96	Matrix	: Water
Date Received	: 11/14/96	Lab File No.	: HALL1121\021F0101
Date Prepared	: 11/21/96	Method Blank	: RB112196
Date Analyzed	: 11/21/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0[illegible]
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 79% 70% - 130% (QC limits)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4033.XLS; 11/26/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: W1	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4033-06	Lab Project No.	: 96-4033
Date Sampled	: 11/13/96	Matrix	: Water
Date Received	: 11/14/96	Lab File No.	: HALL1121\022F0101
Date Prepared	: 11/21/96	Method Blank	: RB112196
Date Analyzed	: 11/21/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 72% 70% - 130% (QC limits)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4033.XLS; 11/26/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	:	Trip Blank	Client Project No.	:	729691.32010
Lab Sample No.	:	96-4033-07	Lab Project No.	:	96-4033
Date Sampled	:	11/13/96	Matrix	:	Water
Date Received	:	11/14/96	Lab File No.	:	HALL1121\023F0101
Date Prepared	:	11/21/96	Method Blank	:	RB112196
Date Analyzed	:	11/21/96	Dilution Factor	:	1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.4
1,1,2,2-Tetrachloroethane	79-34-5	U	0.42
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	73%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4033.XLS; 11/26/96

Method 8010 Quality Control Samples

Date Performed: 11/21/96 Reference Standard: V832

Analyte	M	Method Blank	Sample 96-4033-02	Sample Spike	Spike Dup.	Control Spike	Spike Amt	RPD	Spike Recoveries Sample	Dup	#	Control	#	QC Recovery Range %L - %H	Low - High
Vinyl Chloride	w			13.283	14.878	15.321	20.0	11.3	66%	74%		77%		28 - 163	5.60 - 32.60
Chloroethane	*			16.436	17.331	17.177	20.0	5.3	82%	87%		86%		46 - 137	9.20 - 27.40
1,1-Dichloroethene	*			17.049	17.216	18.277	20.0	1.0	85%	86%		91%		28 - 167	5.60 - 33.40
Dichloromethane	*			16.163	16.26	16.526	20.0	0.6	81%	81%		83%		25 - 162	5.00 - 32.40
trans-1,2-Dichloroethene	*			20.881	20.771	21.672	20.0	0.5	104%	104%		108%		38 - 155	7.60 - 31.00
1,1-Dichloroethane	*			18.409	18.937	18.876	20.0	2.8	92%	95%		94%		47 - 132	9.40 - 26.40
cis-1,2-Dichloroethene	*			18.726	18.512	19.425	20.0	1.1	94%	93%		97%		-	-
1,1,1-Trichloroethane	*			18.083	18.089	19.867	20.0	0.0	90%	90%		99%		41 - 138	8.20 - 27.60
Carbon Tetrachloride	*			18.54	18.589	19.370	20.0	0.3	93%	93%		97%		43 - 143	8.60 - 28.60
Trichloroethene	w			19.47	19.231	20.550	20.0	1.2	97%	96%		103%		35 - 146	7.00 - 29.20
1,1,2-Trichloroethane	w			19.725	19.42	19.498	20.0	1.6	99%	97%		97%		39 - 136	7.80 - 27.20
Tetrachloroethene	*			18.183	17.756	18.182	20.0	2.4	91%	89%		91%		26 - 162	5.20 - 32.40
1,1,1,2-Tetrachloroethane	*			16.532	15.92	17.703	20.0	3.8	83%	80%		89%		-	-
Chlorobenzene	*			17.691	18.375	19.046	20.0	3.8	88%	92%		95%		1 - 150	0.16 - 30.00
1,1,2,2-Tetrachloroethane	*			19.769	20.198	20.962	20.0	2.1	99%	101%		105%		8 - 184	1.60 - 36.80
2-Chlorotoluene	*			17.15	16.509	17.441	20.0	3.8	86%	83%		87%		-	-
4-Chlorotoluene	*			16.472	16.38	16.153	20.0	0.6	82%	82%		81%		-	-
1,3-Dichlorobenzene	*			16.387	16.588	16.877	20.0	1.2	82%	83%		84%		7 - 187	1.40 - 37.40
1,2-Dichlorobenzene	*			12.762	14.096	15.866	20.0	9.9	64%	70%		79%		0 - 208	0.00 - 41.60

M = Applicable matrices. (* = Soil and Water. w = Water only.)

= Marks a spike recovery out of limits.
If recovery is outside method limit, marked with "*".
If recovery is outside a guideline, marked with "~".
If the sample spike recovery is outside the limit and the control spike is outside the limit also, the control is marked with "**" or "~~".

Notes on recovery limits:
All spiked analytes must be detected even if low limit is 0.
For analytes not listed in the method, recovery limits of 50-150% will be used as guidelines until limits can be established.

Corrective Actions:
Unacceptable sample spike recovery requires acceptable control spike recovery. If both recoveries are outside limits, corrective action must be taken. One recovery outside limits and the other acceptable, is a warning. Repeated failure requires corrective action. Recoveries outside guidelines should be compared to historical data available to determine if corrective action is required.

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form
Method Blank Report

Method Blank Number	: GB112196	Client Project No.	: 729691.32010
Date Extracted/Prepared	: 11/21/96	Lab Work Order	: 96-4033
Date Analyzed	: 11/21/96	Dilution Factor	: 1.00
		Method	: RSKSOP-175M
		Matrix	: Water
		Lab File No.	: GAS1121002

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: W81	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4033-03	Lab Work Order	: 96-4033
Date Sampled	: 11/13/96	Dilution Factor	: 50.00
Date Received	: 11/14/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/21/96	Matrix	: Water
Date Analyzed	: 11/21/96	Lab File No.	: GAS1121010

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.7	0.1

rature	: 74 F	Saturation Concentration	Meth	0.164163893
A nt Injected	: 0.01 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.515304837
Head space created	: 4 ml			
Methane Area	: 76.351 ug			

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
\ =Not Available/Not Applicable.

Analyst

K. Hollman
Approved

AF4033.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: LF6-MPM	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4033-04	Lab Work Order	: 96-4033
Date Sampled	: 11/13/96	Dilution Factor	: 1.00
Date Received	: 11/14/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/21/96	Matrix	: Water
Date Analyzed	: 11/21/96	Lab File No.	: GAS1121011

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Temperature	:	74.2 F
Amount Injected	:	0.5 ml
Total Volume of Sample	:	43 ml
Head space created	:	4 ml
Methane Area	:	0 ug

Saturation Concentration	Meth	
Concentration in Head Space	Meth	

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Hollman
Approved

AF4033.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: LF6-MPM	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4033-04Dup	Lab Work Order	: 96-4033
Date Sampled	: 11/13/96	Dilution Factor	: 1.00
Date Received	: 11/14/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/21/96	Matrix	: Water
Date Analyzed	: 11/21/96	Lab File No.	: GAS1121012

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Temperature	:	74.2 F
Amount Injected	:	0.5 ml
Total Volume of Sample	:	43 ml
Head space created	:	4 ml
Methane Area	:	0 ug
Atomic weight(Methane)	:	16 g

Saturation Concentration	Meth	0
Concentration in Head Space	Meth	0

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA =Not Available/Not Applicable.

Analyst

K Hellman
Approved

AF4033.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: W22	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4033-05	Lab Work Order	: 96-4033
Date Sampled	: 11/13/96	Dilution Factor	: 1.00
Date Received	: 11/14/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/21/96	Matrix	: Water
Date Analyzed	: 11/21/96	Lab File No.	: GAS1121013

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Temperature	:	74.3 F
Amount Injected	:	0.5 ml
Total Volume of Sample	:	43 ml
Head space created	:	4 ml
Methane Area	:	0 ug

Saturation Concentration	Meth	
Concentration in Head Space	Meth	

Atomic weight(Methane) : 16 g

Qualifiers

E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

Approved

AF4033.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: W1	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4033-06	Lab Work Order	: 96-4033
Date Sampled	: 11/13/96	Dilution Factor	: 1.00
Date Received	: 11/14/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/21/96	Matrix	: Water
Date Analyzed	: 11/21/96	Lab File No.	: GAS1121014

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

[illegible]rature	:	74.7 F
A[illegible]t Injected	:	0.5 ml
Total Volume of Sample	:	43 ml
Head space created	:	4 ml
Methane Area	:	0 ug
Atomic weight(Methane)	:	16 g

Saturation Concentration	Meth	0
Concentration in Head Space	Meth	0

Qualifiers

E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
[illegible]A =Not Available/Not Applicable.

Bill McWhorter
Analyst

K. Hallman
Approved

AF4033.XLS

Evergreen Analytical, Inc.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

RSKSOP-175M Gas Method
Methane Gas Matrix Spike / Matrix Spike Duplicate Report

Client Sample No.	: W22	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4033-05	Lab Work Order	: 96-4033
Date Sampled	: 11/13/96	EPA Method No.	: RSKSOP-175M
Date Received	: 11/14/96	Matrix	: Water
Date Prepared	: 11/21/96	Method Blank	: GB112196
Date Analyzed	: 11/21/96	Lab File No's.	: GAS1121022,023
E.A. MS/MSD Spike Source No.	: 1886		

Compound	Spike Added (ug)	Sample Concentration (ug)	MS Concentration (ug)	MS %REC	QC Limits %REC
Methane Gas	500	0	329	66	47-88

Compound	Spike Added (ug)	MSD Concentration (ug)	MSD %REC	RPD	QC Limits RPD	QC Limits %REC
Methane Gas	500	341	68	3.5	0-16.4	47-88

RPD: 0 out of (1) outside limits.
Spike Recovery: 0 out of (2) outside limits.

Notes
* = Values outside of QC limits.
NA = Not analyzed/not available

Note: The Spike was made by taking the sample and displacing 4ml of headspace with a 1% methane gas and shaking the VOA for 5 minutes. Then injecting 50 ul from the headspace into the GC resulting in a theoretical concentration of 500 ug.

Analyst

K. Hollman
Approved

MS4033.XLS; 11/22/96

Evergreen Analytical, Inc.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

RSKSOP-175M Gas Method
Methane LCS Report Form

LCS No.	: LCS112196	EPA Method No.	: RSKSOP-175M
Date Prepared	: 11/21/96	Matrix	: Water
Date Analyzed	: 11/21/96	Method Blank	: GB112196
E.A. LCS Source No.	: 1886	Lab File No.	: GAS1121006

Compound	Spike Added (ug)	Method Blank Concentration (ug)	LCS Concentration (ug)	LCS %REC	QC Limits %REC
Methane Gas	500	0	409	82	64-90

Spike Recovery: 0 out of (1) outside limits.

Note: The LCS was made by taking the sample and displacing 4ml of headspace with a 1% methane gas and shaking the VOA for 5 minutes. Then injecting 50 ul from the headspace into the GC resulting in a theoretical concentration of 500 ug.

Notes
* = Values outside of QC limits.
NA = Not analyzed/not available.

Analyst

K. Hillman
Approved

LCS1121.XLS; 11/22/96

Evergreen Analytical, Inc.

96-4047

WORK ORDER Summary

19-Nov-96

Report To: Dave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Client Project ID: 729691.32010

Phone: (303) 831-8100
FAX: (303) 831-8208

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-4047-01K	LF6 MPO	Anions by IC Cl,NO2,NO3,SO4		Water	D4	14-Nov-96	15-Nov-96	02-Dec-96	16-Nov-96
96-4047-02K	LF6 MPP	Anions by IC Cl,NO2,NO3,SO4						02-Dec-96	16-Nov-96
96-4047-03K	W 78	Anions by IC Cl,NO2,NO3,SO4						02-Dec-96	16-Nov-96
96-4047-04K	W 21	Anions by IC Cl,NO2,NO3,SO4						02-Dec-96	16-Nov-96
96-4047-05K	W 20	Anions by IC Cl,NO2,NO3,SO4						02-Dec-96	16-Nov-96
96-4047-07K	LF6 MPQ	Anions by IC Cl,NO2,NO3,SO4						02-Dec-96	16-Nov-96
96-4047-01D	LF6 MPO	BTEX (Parsons List)			2			02-Dec-96	28-Nov-96
96-4047-02D	LF6 MPP	BTEX (Parsons List)						02-Dec-96	28-Nov-96
96-4047-03D	W 78	BTEX (Parsons List)						02-Dec-96	28-Nov-96
96-4047-04D	W 21	BTEX (Parsons List)						02-Dec-96	28-Nov-96
96-4047-05D	W 20	BTEX (Parsons List)						02-Dec-96	28-Nov-96
96-4047-07D	LF6 MPQ	BTEX (Parsons List)						02-Dec-96	28-Nov-96
96-4047-08A	Trip Blank-5	BTEX (Parsons List)			9			02-Dec-96	28-Nov-96
96-4047-01H	LF6 MPO	Methane			2			02-Dec-96	28-Nov-96
96-4047-02H	LF6 MPP	Methane						02-Dec-96	28-Nov-96
96-4047-03H	W 78	Methane						02-Dec-96	28-Nov-96
96-4047-04H	W 21	Methane						02-Dec-96	28-Nov-96
96-4047-05H	W 20	Methane						02-Dec-96	28-Nov-96

# = Special list. See sample comments or test information.
HT = Holding Time expiration date.

DM 11/19/96

Evergreen Analytical, Inc.

96-4047

WORK ORDER Summary

19-Nov-96

Report To: Dave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Client Project ID: 729691.32010

Phone: (303) 831-8100
FAX: (303) 831-8208

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-4047-07H	LF6 MPQ	Methane		Water	2	14-Nov-96	15-Nov-96	02-Dec-96	28-Nov-96
96-4047-01A	LF6 MPO	Purgeable Halocarbons 8010			9			02-Dec-96	28-Nov-96
96-4047-02A	LF6 MPP	Purgeable Halocarbons 8010						02-Dec-96	28-Nov-96
96-4047-03A	W 78	Purgeable Halocarbons 8010						02-Dec-96	28-Nov-96
96-4047-04A	W 21	Purgeable Halocarbons 8010						02-Dec-96	28-Nov-96
96-4047-05A	W 20	Purgeable Halocarbons 8010						02-Dec-96	28-Nov-96
96-4047-06A	W 2	Purgeable Halocarbons 8010						02-Dec-96	28-Nov-96
96-4047-07A	LF6 MPQ	Purgeable Halocarbons 8010						02-Dec-96	28-Nov-96
96-4047-08A	Trip Blank-5	Purgeable Halocarbons 8010						02-Dec-96	28-Nov-96
96-4047-01L	LF6 MPO	Total Alkalinity			D4			02-Dec-96	28-Nov-96
96-4047-02L	LF6 MPP	Total Alkalinity						02-Dec-96	28-Nov-96
96-4047-03L	W 78	Total Alkalinity						02-Dec-96	28-Nov-96
96-4047-04L	W 21	Total Alkalinity						02-Dec-96	28-Nov-96
96-4047-05L	W 20	Total Alkalinity						02-Dec-96	28-Nov-96
96-4047-07L	LF6 MPQ	Total Alkalinity						02-Dec-96	28-Nov-96
96-4047-01M	LF6 MPO	Total Organic Carbon						02-Dec-96	12-Dec-96
96-4047-02M	LF6 MPP	Total Organic Carbon						02-Dec-96	12-Dec-96
96-4047-03M	W 78	Total Organic Carbon						02-Dec-96	12-Dec-96
96-4047-04M	W 21	Total Organic Carbon						02-Dec-96	12-Dec-96
96-4047-01D	LF6 MPO	TVH (Gasoline)			2			02-Dec-96	28-Nov-96
96-4047-02D	LF6 MPP	TVH (Gasoline)						02-Dec-96	28-Nov-96
96-4047-03D	W 78	TVH (Gasoline)						02-Dec-96	28-Nov-96
96-4047-04D	W 21	TVH (Gasoline)						02-Dec-96	[illegible]Nov-96

# = Spe[illegible] See sample comments or test information.
HT = Holding Time expiration date.

WORK ORDER Summary

19-Nov-96

Report To: Dave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Client Project ID: 729691.32010

Phone: (303) 831-8100
FAX: (303) 831-8208

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-4047-05D	W 20	TVH (Gasoline)		Water	2	14-Nov-96	15-Nov-96	02-Dec-96	28-Nov-96
96-4047-06D	W 2	TVH (Gasoline)						02-Dec-96	28-Nov-96
96-4047-07D	LF6 MPQ	TVH (Gasoline)						02-Dec-96	28-Nov-96
96-4047-08A	Trip Blank-5	TVH (Gasoline)			9			02-Dec-96	28-Nov-96

# = Special list. See sample comments or test information.
HT = Holding Time expiration date.

CHAIN OF CUSTODY RECORD / ANALYTICAL SERVICES REQUEST

Page 1 of 1

COMPANY Parsons ES
ADDRESS 1700 Broadway Suite 900
CITY Denver STATE Co ZIP 80290
PHONE# (303) 831-8100 FAX # (303) 831-8206 FAX RESULTS Y / N

Evergreen Analytical Inc.
4036 Youngfield St.
Wheat Ridge, Colorado 80033
(303) 425-6021
FAX (303) 425-6854
(800) 845-7400

CLIENT CONTACT (print) Jenny Hartfelder
CLIENT PROJ. I.D. 72969.32010
EAL. QUOTE # ______ P.O.# 729691.32010
TURNAROUND REQUIRED* ☐ STD (2 wks) ☐ UST
☐ Other (Specify)* ______
*expedited turnaround subject to additional fee

Sampler Name:
(signature) Rob Nagel
(print) ROB NAGEL

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	Water-Drinking/Discharge/Ground (circle)	Soil / Solid / Air / Gas	Oil / Sludge / Multi-phase	TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle) 8010	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	PCB Screen	Herbicides 8150/515 (circle)	BTEX 8020/602 (circle)/MTBE (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	Oil & Grease 413.1	TRPH 418.1	TOC	METHANE	ANIONS (Cl⁻, NO₂, NO₃, SO₄)	ALKALINITY		For Laboratory use only
LF6 MPO	11/14/96	0730	13					X						X	X						X	X	X	X		01 A-M
LF6 MPP	11/14/96	0920	13				*	X						X	X						X	X	X	X		02 A-M
W78	11/14/96	1110	13					X						X	X						X	X	X	X		03 A-M
W21	11/14/96	1320	13					X						X	X						X	X	X	X		04 A-M
W20	11/14/96	1515	12					X						X	X				ND BNA		~~X~~	X	X	X		05 A-L
W2	11/14/96	1130	7					X							X											06 A-6
LF6 MPQ	11/14/96	1645	12					X					*	X	X				ND BNA		~~X~~	X	X	X		07 A-L
TRIP BLANK #5	11/14/96		1					X*						X	X											08A
Sample Fraction								ABC						DEFG							M	~~HIJ~~	K	L		Loc 2, 11, D4
Container								40V						40V							125A	40V	125P	125P		←

For Laboratory use only:
W.O. # 96-4047
B.O.F. # MA
C/S (O) 362 / Co
C/S (I) 362 / Co
Cooler Temp. °C 9
Seals Intact Y / N / NA
Samples Pres Y / N / NA
Headspace Y / N / NA
By PK

Instructions:
*02C and 06G received broken. PK.

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
[redacted]	11/.. 2:30pm		[redacted]			[redacted]	11..

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report
Method Blank Report

Method Blank Number	: MB2111896	Client Project Number	: 729691.32010
Date Prepared	: 11/18/96	Lab Work Order	: 96-4047
Dilution Factor	: 1.0	Matrix	: WATER
		Lab File Number	: TVB21118003

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/18/96	U	0.1	mg/L
Benzene	71-43-2	11/18/96	U	0.4	ug/L
Toluene	108-88-3	11/18/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/18/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/18/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/18/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/18/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/18/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/18/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/18/96	U	0.5	ug/L
FID Surrogate Recovery:		92%		70%-126%	(Limits)
[illegible] Surrogate Recovery:		97%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Blacha
Analyst

K. Hillman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report
Method Blank Report

Method Blank Number	: MB2111996	Client Project Number	: 729691.32010
Date Prepared	: 11/19/96	Lab Work Order	: 96-4047
Dilution Factor	: 1.0	Matrix	: WATER
		Lab File Number	: TVB21118037

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/19/96	U	0.1	mg/L
Benzene	71-43-2	11/19/96	U	0.4	ug/L
Toluene	108-88-3	11/19/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/19/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/19/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/19/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/19/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/19/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/19/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/19/96	U	0.5	ug/L
FID Surrogate Recovery:		96%		70%-126%	(Li
PID Surrogate Recovery:		99%		76%-127%	(Li

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Blecha
Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF6 MPO	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4047-01	Lab Work Order	: 96-4047
Date Sampled	: 11/14/96	Matrix	: WATER
Date Received	: 11/15/96	Lab File Number(s)	: TVB21118019
Date Prepared	: 11/18/96	Method Blank	: MB2111896
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/18/96	U	0.1	mg/L
Benzene	71-43-2	11/18/96	2.0	0.4	ug/L
Toluene	108-88-3	11/18/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/18/96	4.1	0.4	ug/L
Ethyl Benzene	100-41-4	11/18/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/18/96	0.6	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/18/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/18/96	0.6	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/18/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/18/96	U	0.5	ug/L
Surrogate Recovery:		97%		70%-126%	(Limits)
Surrogate Recovery:		97%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Blacha
Analyst

K. Holliman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF6 MPP	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4047-02	Lab Work Order	: 96-4047
Date Sampled	: 11/14/96	Matrix	: WATER
Date Received	: 11/15/96	Lab File Number(s)	: TVB21118022
Date Prepared	: 11/18/96	Method Blank	: MB2111896
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/18/96	U	0.1	mg/L
Benzene	71-43-2	11/18/96	3.4	0.4	ug/L
Toluene	108-88-3	11/18/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/18/96	5.9	0.4	ug/L
Ethyl Benzene	100-41-4	11/18/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/18/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/18/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/18/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/18/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/18/96	U	0.5	u[illegible]
FID Surrogate Recovery:		99%		70%-126%	(L[illegible]
PID Surrogate Recovery:		95%		76%-127%	(Li[illegible]

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Blecha
Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: W78	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4047-03	Lab Work Order	: 96-4047
Date Sampled	: 11/14/96	Matrix	: WATER
Date Received	: 11/15/96	Lab File Number(s)	: TVB21118025
Date Prepared	: 11/18/96	Method Blank	: MB2111896
FID Dilution Factor	: 1.0		1
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/18/96	U	0.1	mg/L
Benzene	71-43-2	11/18/96	U	0.4	ug/L
Toluene	108-88-3	11/18/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/18/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/18/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/18/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/18/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/18/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/18/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/18/96	U	0.5	ug/L
Surrogate Recovery:		101%		70%-126%	(Limits)
Surrogate Recovery:		96%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: W21	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4047-04	Lab Work Order	: 96-4047
Date Sampled	: 11/14/96	Matrix	: WATER
Date Received	: 11/15/96	Lab File Number(s)	: TVB21118026
Date Prepared	: 11/18/96	Method Blank	: MB2111896
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/18/96	U	0.1	mg/L
Benzene	71-43-2	11/18/96	3.6	0.4	ug/L
Toluene	108-88-3	11/18/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/18/96	20	0.4	ug/L
Ethyl Benzene	100-41-4	11/18/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/18/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/18/96	U	0.4	ug/L
1,2,4-Trimethylbenzene •	95-63-6	11/18/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/18/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/18/96	0.5	0.5	ug
FID Surrogate Recovery:		102%		70%-126%	(Li
PID Surrogate Recovery:		96%		76%-127%	(Lim

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Blaha
Analyst

K. Hollman
Approved

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Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: W20	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4047-05	Lab Work Order	: 96-4047
Date Sampled	: 11/14/96	Matrix	: WATER
Date Received	: 11/15/96	Lab File Number(s)	: TVB21118027
Date Prepared	: 11/18/96	Method Blank	: MB2111896
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/19/96	U	0.1	mg/L
Benzene	71-43-2	11/19/96	U	0.4	ug/L
Toluene	108-88-3	11/19/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/19/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/19/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/19/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/19/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/19/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/19/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/19/96	U	0.5	ug/L
Surrogate Recovery:		93%		70%-126%	(Limits)
Surrogate Recovery:		96%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Bleaha
Analyst

K. Hollman
Approved

TVBXWS2P;TV24047P.XLS: 11/20/96: 6

EVERGREEN ANALYTICAL, INC.
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Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: W2	Client Project Number	: 7296[illegible]1.32010
Lab Sample Number	: 96-4047-06	Lab Work Order	: 96-4047
Date Sampled	: 11/14/96	Matrix	: WATER
Date Received	: 11/15/96	Lab File Number(s)	: TVB21118028
Date Prepared	: 11/18/96	Method Blank	: MB2111896
FID Dilution Factor	: 1.0		
PID Dilution Factor	: NA		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/19/96	U	0.1	mg/L
Benzene	71-43-2	NA	NA	NA	NA
Toluene	108-88-3	NA	NA	NA	NA
Chlorobenzene	108-90-7	NA	NA	NA	NA
Ethyl Benzene	100-41-4	NA	NA	NA	NA
Total Xylenes (m,p,o)	1330-20-7	NA	NA	NA	NA
1,3,5-Trimethylbenzene	108-67-8	NA	NA	NA	NA
1,2,4-Trimethylbenzene	95-63-6	NA	NA	NA	NA
1,2,3-Trimethylbenzene	526-73-8	NA	NA	NA	NA
1,2,3,4-Tetramethylbenzene	488-23-3	NA	NA	NA	N[illegible]
FID Surrogate Recovery:		97%		70%-126%	(Li[illegible]
PID Surrogate Recovery:	NA			76%-127%	(Li[illegible]

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Bleaha
Analyst

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(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF6 MPQ	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4047-07	Lab Work Order	: 96-4047
Date Sampled	: 11/14/96	Matrix	: WATER
Date Received	: 11/15/96	Lab File Number(s)	: TVB21118031
Date Prepared	: 11/18/96	Method Blank	: MB2111896
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/19/96	U	0.1	mg/L
Benzene	71-43-2	11/19/96	U	0.4	ug/L
Toluene	108-88-3	11/19/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/19/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/19/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/19/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/19/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/19/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/19/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/19/96	U	0.5	ug/L
Surrogate Recovery:		100%		70%-126%	(Limits)
D Surrogate Recovery:		96%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
H = Total Volatile Hydrocarbons.

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Analyst

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Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	:	TRIP BLANK-5	Client Project Number	:	729691.32010
Lab Sample Number	:	96-4047-08	Lab Work Order	:	96-4047
Date Sampled	:	NA	Matrix	:	WATER
Date Received	:	11/15/96	Lab File Number(s)	:	TVB21118035
Date Prepared	:	11/18/96	Method Blank	:	MB2111896
FID Dilution Factor	:	1.0			
PID Dilution Factor	:	1.0			

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/19/96	U	0.1	mg/L
Benzene	71-43-2	11/19/96	U	0.4	ug/L
Toluene	108-88-3	11/19/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/19/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/19/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/19/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/19/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/19/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/19/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/19/96	U	0.5	ug
FID Surrogate Recovery:		92%		70%-126%	(Li
PID Surrogate Recovery:		95%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Rlecha
Analyst

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Approved

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TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
TVH Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: LF6 MPO	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4047-01	Lab Work Order	: 96-4047
Date Sampled	: 11/14/96	EPA Method No.	: 5030/8015 Modified
Date Received	: 11/15/96	Matrix	: WATER
Date Prepared	: 11/18/96	Lab File Number(s)	: TVB2118020,21
Date Analyzed	: 11/18/96	Method Blank	: MB211896
Instrument Name	: TVHBTEX2	Dilution Factor	: 1.0

Compound	Spike Added (mg/L)	Sample Concentration (mg/L)	MS Concentration (mg/L)	MS %REC	QC (#) Limits %REC
Gasoline	2.00	0.00	2.16	107.8%	60 - 128
Surrogate **	---	---	---	118%	70 - 126

Compound	Spike Added (mg/L)	MSD Concentration (mg/L)	MSD %REC	RPD	QC (#) Limits	
					RPD	%REC
Gasoline	2.00	2.20	110.1%	2.1	44.1	60 - 128
Surrogate **	---	---	117%	NA	NA	70 - 126

RPD: 0 out of (1) outside limits.
Spike Recovery: 0 out of (2) outside limits.

Notes:
NA = Not analyzed/not applicable.
* = Values outside of QC limits.
** = 1,2,4-Trichlorobenzene
# = Limits established 10/1/96, MAB

Comments:

M. Bleaka
Analyst

K Holliman
Approved

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EPA 602/8020 Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: W78	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4047-03	Lab Work Order	: 96-4047
Date Sampled	: 11/14/96	EPA Method No.	: 602/8020
Date Received	: 11/15/96	Matrix	: WATER
Date Prepared	: 11/19/96	Lab File Number(s)	: TVB21118038,39
Date Analyzed	: 11/19/96	Method Blank	: MB2111996
Instrument Name	: TVHBTEX2	Dilution Factor	: 1.0

Compound	Spike Added (ug/L)	Sample Concentration (ug/L)	Concentration (ug/L) MS	Concentration (ug/L) MSD	Comments
Benzene	20.0	0.0	20.1	21.4	
Toluene	20.0	0.0	19.6	20.9	
Chlorobenzene	20.0	0.0	19.6	20.8	
Ethylbenzene	20.0	0.0	19.6	20.9	
m,p-Xylene	20.0	0.0	19.6	20.9	
o-Xylene	20.0	0.0	19.6	20.7	
1,3,5-TMB	20.0	0.0	19.4	20.5	
1,2,4-TMB	20.0	0.0	19.1	20.2	
1,2,3-TMB	20.0	0.0	19.9	20.9	
1,2,3,4-TeMB	20.0	0.0	20.4	21.6	
Surrogate	100.0	96%	102%	105%	% RECOVERY

Compound		MS % RECOVERY	MSD % RECOVERY	RPD	QC# Limits RPD	QC# Limits %REC
Benzene		100.5	107.0	6.3	17	61 - 129
Toluene		98.0	104.5	6.4	18	61 - 127
Chlorobenzene		98.0	104.0	5.9	16	68 - 122
Ethylbenzene		98.0	104.5	6.4	18	63 - 126
m,p-Xylene		98.0	104.5	6.4	18	60 - 130
o-Xylene		98.0	103.5	5.5	18	62 - 128
1,3,5-TMB		97.0	102.5	5.5	18	69 - 117
1,2,4-TMB		95.5	101.0	5.6	23	69 - 119
1,2,3-TMB		99.5	104.5	4.9	16	71 - 118
1,2,3,4-TeMB		102.0	108.0	5.7	27	67 - 125
Surrogate		102.0	105.0	NA	NA	76 - 127

= Limits established 10/15/96, KSH
* = Values outside of QC limits.

RPD: 0 out of (10) outside limits.
Spike Recovery: 0 out of (20) outside limits.

Comments:

M. Blecha
Analyst

K Hollman
Approved

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TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
Laboratory Control Sample (LCS)

LCS Number	: LCS2111896-GAS	Matrix	: WATER
Date Prepared	: 11/18/96	Method Numbers	: EPA 5030/8015 Modified
Date Analyzed	: 11/18/96	Instrument Name	: TVHBTEX2
Lab File Number(s)	: TVB21118013		

Compound Name	Theoretical Concentration (mg/L)	LCS Concentration (mg/L)	LCS % Recovery	QC Limit % Recovery
Gasoline	2.00	2.32	115.9	81 - 128
Surrogate Recovery:		125%		70 - 126

QUALIFIERS
B = TVH as Gasoline found in blank also.
E = Extrapolated value. Value exceeds calibration range.
NA = Not Available/Not Applicable.
** = Limits established 10/1/96 for TVHBTEX2. MAB

M. Blaha
Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
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Wheat Ridge, CO 80033
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EPA 602/8020 Data Report
Laboratory Control Sample (LCS)

LCS Number	:	LCS2111896-BTEX	Dilution Factor	:	1.00
Date Extracted/Prepared	:	11/18/96	Method	:	602/8020
Date Analyzed	:	11/18/96	Matrix	:	Water
Spike Amount (ug/L)	:	20.0	Lab File No.	:	TVB221118014

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit** % Recovery
Benzene	71-43-2	20.6	103.0	75 - 116
Toluene	108-88-3	20.0	100.0	75 - 118
Chlorobenzene	108-90-7	18.2	91.0	73 - 115
Ethyl Benzene	100-41-4	19.7	98.5	80 - 122
m,p-Xylene	108-38-3 106-42-3	38.1	95.3	76 - 120
o-Xylene	95-47-6	20.0	100.0	76 - 1[illegible]
MTBE	1634-04-4	20.5	102.5	75 - 115
1,3,5-Trimethylbenzene	108-67-8	19.6	98.0	64 - 118
1,2,4-Trimethylbenzene	95-63-6	18.1	90.5	75 - 111
1,2,3-Trimethylbenzene	526-73-8	22.6	113.0	82 - 127
1,2,3,4-Tetramethylbenzene	488-23-3	20.6	103.0	72 - 131
Surrogate Recovery:		100%		76 - 127

NOTES: m,p-xylene = 40.0 ppb spike.

QUALIFIERS:

E = Extrapolated value. Value exceeds that of the calibration range.
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
NA = Not available/Not analyzed.
** = Limits established 10/1/96 for TVHBTEX2. MAB

M. Bleeker
Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 8010 Chlorinated VOC's Method Blank Report

Method Blank	: RB112196	Client Project No.	: 729691.32010
Date Prepared	: 11/21/96	Lab Project No.	: 96-4047
Date Analyzed	: 11/21/96	Lab File No.	: HALL1121\004F0101

Compound	CAS #	Concentration (ug/L)	RL(ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
[illegible]-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 81% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4047.XLS; 11/26/96

EVERGREEN ANALYTICAL, INC.
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Method 601/8010 Chlorinated VOC's Method Blank Report

Method Blank	: RB112596	Client Project No.	: 729691.32010
Date Prepared	: 11/25/96	Lab Project No.	: 96-4047
Date Analyzed	: 11/25/96	Lab File No.	: HALL1125\004F0101

Compound	CAS #	Concentration (ug/L)	RL(ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 85% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4047.XLS; 11/26/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF6 MPO	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4047-01	Lab Project No.	: 96-4047
Date Sampled	: 11/14/96	Matrix	: Water
Date Received	: 11/15/96	Lab File No.	: HALL1121\024F0101
Date Prepared	: 11/21/96	Method Blank	: RB112196
Date Analyzed	: 11/21/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	8	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	1	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	0.44 J	0.4
cis-1,2-Dichloroethene	156-59-4	15	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	0.68 J	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	1.6 J	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 86% 70% - 130% (QC limits)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES: ______________________________

Analyst

Approved

HLW4047.XLS; 11/26/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF6 MPP	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4047-02	Lab Project No.	: 96-4047
Date Sampled	: 11/14/96	Matrix	: Water
Date Received	: 11/15/96	Lab File No.	: HALL1121\025F0101
Date Prepared	: 11/21/96	Method Blank	: RB112196
Date Analyzed	: 11/22/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	9	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	0.49 J	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	7.5	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	2.3	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	0.74 J	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 84% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: W78	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4047-03	Lab Project No.	: 96-4047
Date Sampled	: 11/14/96	Matrix	: Water
Date Received	: 11/15/96	Lab File No.	: HALL1121\026F0101
Date Prepared	: 11/21/96	Method Blank	: RB112196
Date Analyzed	: 11/22/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 81% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: W21	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4047-04	Lab Project No.	: 96-4047
Date Sampled	: 11/14/96	Matrix	: Water
Date Received	: 11/15/96	Lab File No.	: HALL1121\027F0101
Date Prepared	: 11/21/96	Method Blank	: RB112196
Date Analyzed	: 11/22/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	10	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	0.43 J	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	0.81 J	0.4
cis-1,2-Dichloroethene	156-59-4	14	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	7.4	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	13	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	1.9	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 86% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: W20	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4047-05	Lab Project No.	: 96-4047
Date Sampled	: 11/14/96	Matrix	: Water
Date Received	: 11/15/96	Lab File No.	: HALL1121\028F0101
Date Prepared	: 11/21/96	Method Blank	: RB112196
Date Analyzed	: 11/22/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
[illegible]Chlorotoluene	95-49-8	U	0.4
[illegible]hlorotoluene	106-49-8	U	0.4
[illegible],3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 77% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: W2	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4047-06	Lab Project No.	: 96-4047
Date Sampled	: 11/14/96	Matrix	: Water
Date Received	: 11/15/96	Lab File No.	: HALL1125\006F0101
Date Prepared	: 11/25/96	Method Blank	: RB112596
Date Analyzed	: 11/25/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 88% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF6 MPQ	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4047-07	Lab Project No.	: 96-4047
Date Sampled	: 11/14/96	Matrix	: Water
Date Received	: 11/15/96	Lab File No.	: HALL1125\007F0101
Date Prepared	: 11/25/96	Method Blank	: RB112596
Date Analyzed	: 11/25/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 90% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: Trip Blank-5	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4047-08	Lab Project No.	: 96-4047
Date Sampled	: 11/14/96	Matrix	: Water
Date Received	: 11/15/96	Lab File No.	: HALL1125\008F0101
Date Prepared	: 11/25/96	Method Blank	: RB112596
Date Analyzed	: 11/25/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 85% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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HLW4047.XLS; 11/26/96

Method 8010 [illegible]ty Control Samples

Date Performed: 11/21/96 Reference Standard: V832

Analyte	M	Method Blank	Sample 96-4047-05	Sample Spike	Spike Dup.	Control Spike	Spike Amt	RPD	Spike Recoveries Sample	Dup	#	Control	#	QC Recovery Range %L - %H	Low - High
Vinyl Chloride	w			16.242	16.939	18.000	20.0	4.2	81%	85%		90%		28 - 163	5.60 - 32.60
Chloroethane	*			18.077	18.149	18.375	20.0	0.4	90%	91%		92%		46 - 137	9.20 - 27.40
1,1-Dichloroethene	*			18.412	18.596	18.944	20.0	1.0	92%	93%		95%		28 - 167	5.60 - 33.40
Dichloromethane	*			16.549	17.379	17.787	20.0	4.9	83%	87%		89%		25 - 162	5.00 - 32.40
trans-1,2-Dichloroethene	*			22.277	22.808	22.588	20.0	2.4	111%	114%		113%		38 - 155	7.60 - 31.00
1,1-Dichloroethane	*			19.461	19.864	20.012	20.0	2.0	97%	99%		100%		47 - 132	9.40 - 26.40
cis-1,2-Dichloroethene	*			19.861	20.366	20.446	20.0	2.5	99%	102%		102%		-	-
1,1,1-Trichloroethane	*			19.811	20.244	20.065	20.0	2.2	99%	101%		100%		41 - 138	8.20 - 27.60
Carbon Tetrachloride	*			20.406	20.554	20.471	20.0	0.7	102%	103%		102%		43 - 143	8.60 - 28.60
Trichloroethene	w			20.741	21.314	20.734	20.0	2.7	104%	107%		104%		35 - 146	7.00 - 29.20
1,1,2-Trichloroethane	w			19.987	18.51	19.862	20.0	7.7	100%	93%		99%		39 - 136	7.80 - 27.20
Tetrachloroethene	*			19.678	19.422	19.850	20.0	1.3	98%	97%		99%		26 - 162	5.20 - 32.40
1,1,1,2-Tetrachloroethane	*			18.214	18.494	18.133	20.0	1.5	91%	92%		91%		-	-
Chlorobenzene	*			18.85[illegible]	20.447	18.803	20.0	8.1	94%	102%		94%		1 - 150	0.16 - 30.00
1,1,2,2-Tetrachloroethane	*			18.777	17.532	21.414	20.0	6.9	94%	88%		107%		8 - 184	1.60 - 36.80
2-Chlorotoluene	*			18.101	18.118	19.399	20.0	0.1	91%	91%		97%		-	-
4-Chlorotoluene	*			17.338	16.991	18.771	20.0	2.0	87%	85%		94%		-	-
1,3-Dichlorobenzene	*			16.993	17.568	17.339	20.0	3.3	85%	88%		87%		7 - 187	1.40 - 37.40
1,2-Dichlorobenzene	*			16.648	15.984	16.729	20.0	4.1	83%	80%		84%		0 - 208	0.00 - 41.60

M = Applicable matrices. (* = Soil and Water. w = Water only.)

= Marks a spike recovery out of limits.
If recovery is outside method limit, marked with "*".
If recovery is outside a guideline, marked with "~".
If the sample spike recovery is outside the limit and the control spike is outside the limit also, the control is marked with "**" or "~~".

Notes on recovery limits:
All spiked analytes must be detected even if low limit is 0.
For analytes not listed in the method, recovery limits of 50-150% will be used as guidelines until limits can be established.

Corrective Actions:
Unacceptable sample spike recovery requires acceptable control spike recovery. If both recoveries are outside limits, corrective action must be taken. One recovery outside limits and the other acceptable, is a warning. Repeated failure requires corrective action. Recoveries outside guidelines should be compared to historical data available to determine if corrective action is required.

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form
Method Blank Report

Method Blank Number	: GB112196	Client Project No.	: 729691.32010
Date Extracted/Prepared	: 11/21/96	Lab Work Order	: 96-4047
Date Analyzed	: 11/21/96	Dilution Factor	: 1.00
		Method	: RSKSOP-175M
		Matrix	: Water
		Lab File No.	: GAS1121002

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: LF6 MPO	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4047-01	Lab Work Order	: 96-4047
Date Sampled	: 11/14/96	Dilution Factor	: 50.00
Date Received	: 11/15/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/21/96	Matrix	: Water
Date Analyzed	: 11/21/96	Lab File No.	: GAS1121016

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	1.8	0.1

Temperature	: 73.8 F	Saturation Concentration	Meth	0.443690383
nt Injected	: 0.01 ml			
Volume of Sample	: 43 ml	Concentration in Head Space	Meth	1.393251313
Head space created	: 4 ml			
Methane Area	: 206.356 ug			
Atomic weight(Methane)	: 16 g			

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
'A = Not Available/Not Applicable.

Analyst

K. Hallman
Approved

AF4047.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: LF6 MPP	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4047-02	Lab Work Order	: 96-4047
Date Sampled	: 11/14/96	Dilution Factor	: 100.00
Date Received	: 11/15/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/21/96	Matrix	: Water
Date Analyzed	: 11/21/96	Lab File No.	: GAS1121017

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	2.7	0.2

Temperature	:	74.4 F
Amount Injected	:	0.005 ml
Total Volume of Sample	:	43 ml
Head space created	:	4 ml
Methane Area	:	149.023 ug

Saturation Concentration	Meth	0.6408[illegible]98
Concentration in Head Space	Meth	2.010[illegible]70

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Hallman
Approved

AF4047.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: W78	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4047-03	Lab Work Order	: 96-4047
Date Sampled	: 11/14/96	Dilution Factor	: 1.00
Date Received	: 11/15/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/21/96	Matrix	: Water
Date Analyzed	: 11/21/96	Lab File No.	: GAS1121018

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.021	0.002

erature	: 74.1 F	Saturation Concentration	Meth	0.004974606
nt Injected	: 0.5 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.015612191
Head space created	: 4 ml			
Methane Area	: 115.682 ug			

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
N =Not Available/Not Applicable.

Analyst

K. Hollman
Approved

AF4047.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: W21	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4047-04	Lab Work Order	: 96-4047
Date Sampled	: 11/14/96	Dilution Factor	: 50.00
Date Received	: 11/15/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/21/96	Matrix	: Water
Date Analyzed	: 11/21/96	Lab File No.	: GAS1121019

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	2.7	0.1

Temperature	:	74.3 F
Amount Injected	:	0.01 ml
Total Volume of Sample	:	43 ml
Head space created	:	4 ml
Methane Area	:	306.361 ug

Saturation Concentration	Meth	0.65[illegible]
Concentration in Head Space	Meth	2.0665160

Atomic weight(Methane) : 16 g

Qualifiers

E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K Hollman
Approved

AF4047.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: W20	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4047-05	Lab Work Order	: 96-4047
Date Sampled	: 11/14/96	Dilution Factor	: 1.00
Date Received	: 11/15/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/21/96	Matrix	: Water
Date Analyzed	: 11/21/96	Lab File No.	: GAS1121020

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

erature	: 75.2 F	Saturation Concentration	Meth	0
nt Injected	: 0.5 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0
Head space created	: 4 ml			
Methane Area	: 0 ug			

Atomic weight(Methane) : 16 g

Qualifiers

E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

Approved

AF4047.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: LF6 MPQ	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4047-07	Lab Work Order	: 96-4047
Date Sampled	: 11/14/96	Dilution Factor	: 1.00
Date Received	: 11/15/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/21/96	Matrix	: Water
Date Analyzed	: 11/21/96	Lab File No.	: GAS1121021

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Temperature	:	75.4 F
Amount Injected	:	0.5 ml
Total Volume of Sample	:	43 ml
Head space created	:	4 ml
Methane Area	:	0 ug

Saturation Concentration	Meth	
Concentration in Head Space	Meth	

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Hollman
Approved

AF4047.XLS

Evergreen Analytical, Inc.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

RSKSOP-175M Gas Method
Methane LCS Report Form

LCS No.	: LCS112196	EPA Method No.	: RSKSOP-175M
Date Prepared	: 11/21/96	Matrix	: Water
Date Analyzed	: 11/21/96	Method Blank	: GB112196
E.A. LCS Source No.	: 1886	Lab File No.	: GAS1121006

Compound	Spike Added (ug)	Method Blank Concentration (ug)	LCS Concentration (ug)	LCS %REC	QC Limits %REC
Methane Gas	500	0	409	82	64-90

Spike Recovery: 0 out of (1) outside limits.

Note: The LCS was made by taking the sample and displacing 4ml of headspace with a 1% methane gas and shaking the VOA for 5 minutes. Then injecting 50 ul from the headspace into the GC resulting in a theoretical concentration of 500 ug.

Notes
* = Values outside of QC limits.
NA = Not analyzed/not available.

Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/14/96		Client Project ID.	:	72969.32010
Date Received	: 11/15/96		Lab Project Number	:	96-4047
Date Prepared	: 11/15/96		Method	:	EPA 300.0
Date Analyzed	: 11/15/96		Detection Limit	:	0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Chloride mg/L	Dilution Factor
96-4047-01	LF6 MPO	Water	177	10
96-4047-02	LF6 MPP	Water	44.2	10
96-4047-03	W78	Water	17.5	1
96-4047-03 Duplicate	W78 Duplicate	Water	17.0	1
96-4047-04	W21	Water	54.1	10
96-4047-05	W20	Water	6.7	1
96-4047-07	LF6 MPQ	Water	70.7	10
Method Blank	(11/15/96)	Water	<0.25	1

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4047-03	W78 Matrix Spike	10.0	17.5	27.9	104
96-4047-03	W78 Matrix Spike Dup	10.0	17.5	27.7	102
MS/MSD RPD					1.9

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/14/96		Client Project ID.	: 72969.32010
Date Received	: 11/15/96		Lab Project Number	: 96-4047
Date Prepared	: 11/15/96		Method	: EPA 300.0
Date Analyzed	: 11/15/96		Detection Limit	: 0.076 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrite-N mg/L	Dilution Factor
96-4047-01	LF6 MPO	Water	<0.76**	10
96-4047-02	LF6 MPP	Water	<0.076	1
96-4047-03	W78	Water	<0.076	1
96-4047-03 Duplicate	W78 Duplicate	Water	<0.076	1
96-4047-04	W21	Water	<0.076	1
96-4047-05	W20	Water	<0.076	1
96-4047-07	LF6 MPQ	Water	<0.076	1
Method Blank	(11/15/96)	Water	<0.076	1

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4047-03	W78 Matrix Spike	10.0	<0.25	9.7	97
96-4047-03	W78 Matrix Spike Dup	10.0	<0.25	9.5	95
MS/MSD RPD					1.5

* = Quality assurance results reported as Nitrite (NO_2).
** = Raised detection limit due to matrix interference.

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/14/96		Client Project ID.	:	72969.32010
Date Received	: 11/15/96		Lab Project Number	:	96-4047
Date Prepared	: 11/15/96		Method	:	EPA 300.0
Date Analyzed	: 11/15/96		Detection Limit	:	0.056 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrate-N mg/L	Dilution Factor
96-4047-01	LF6 MPO	Water	0.35	1
96-4047-02	LF6 MPP	Water	0.073	1
96-4047-03	W78	Water	<0.056	1
96-4047-03 Duplicate	W78 Duplicate	Water	<0.056	1
96-4047-04	W21	Water	0.38	1
96-4047-05	W20	Water	2.5	1
96-4047-07	LF6 MPQ	Water	1.5	1
Method Blank	(11/15/96)	Water	<0.056	1

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4047-03	W78 Matrix Spike	10.0	<0.25	9.5	95
96-4047-03	W78 Matrix Spike Dup	10.0	<0.25	9.4	94
MS/MSD RPD					1.7

* = Quality assurance results reported as Nitrate (NO_3).

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/14/96	Client Project ID.	: 72969.32010
Date Received	: 11/15/96	Lab Project Number	: 96-4047
Date Prepared	: 11/15/96	Method	: EPA 300.0
Date Analyzed	: 11/15/96	Detection Limit	: 0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Sulfate mg/L	Dilution Factor
96-4047-01	LF6 MPO	Water	6.0	1
96-4047-02	LF6 MPP	Water	2.2	1
96-4047-03	W78	Water	50.6	10
96-4047-03 Duplicate	W78 Duplicate	Water	50.7	10
96-4047-04	W21	Water	<0.25	1
96-4047-05	W20	Water	0.41	1
96-4047-07	LF6 MPQ	Water	0.34	1
Method Blank	(11/15/96)	Water	<0.25	1

Quality Assurance*

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4047-03	W78 Matrix Spike	10.0	5.1	14.6	96
96-4047-03	W78 Matrix Spike Dup	10.0	5.1	14.5	94
MS/MSD RPD					1.3

* = Quality assurance based on a sample dilution factor of 10.

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Total Organic Carbon

Date Sampled	:	11/14/96	Client Project ID.	:	729691.32010
Date Received	:	11/15/96	Lab Project Number	:	96-4047
Date Prepared	:	11/25/96	Method	:	EPA 415.1
Date Analyzed	:	11/25/96	Detection Limit	:	1.0 mg C/L

Evergreen Sample #	Client Sample ID.	Matrix	TOC mg C/L	Dilution Factor
96-4047-01	LF6 MPO	Water	34.7	1
96-4047-01 Duplicate	LF6 MPO Duplicate	Water	34.6	1
96-4047-02	LF6 MPP	Water	3.4	1
96-4047-03	W 78	Water	2.1	1
96-4047-04	W 21	Water	4.6	1
Method Blank	(11/25/96)		<1.0	

Quality Assurance

		Spike Amount (mgC/L)	Sample Result (mgC/L)	Spike Result (mgC/L)	% Recovery
96-4047-01	LF6 MPO Matrix Spike	10.0	34.7	45.6	109
96-4047-01	LF6 MPO Matrix Spike Dup	10.0	34.7	44.7	100
MS/MSD RPD					8.5

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Analysis Report

Date Sampled	: 11/14/96	Client Project ID.	: 72969.32010
Date Received	: 11/15/96	Lab Project Number	: 96-4047
Date Prepared	: 11/18/96	Method	: EPA 310.1
Date Analyzed	: 11/18/96	Detection Limit	: 5.0 mg $CaCO_3$/L

Evergreen Sample #	Client Sample ID.	Matrix	Total Alkalinity (mg $CaCO_3$/L)	Dilution Factor
96-4047-01	LF6 MPO	Water	19.5	1
96-4047-02	LF6 MPP	Water	10.0	1
96-4047-03	W78	Water	<5.0	1
96-4047-04	W21	Water	<5.0	1
96-4047-05	W20	Water	<5.0	1
96-4047-07	LF6 MPQ	Water	21.1	1
96-4047-07 Duplicate	LF6 MPQ Duplicate	Water	21.2	1
Method Blank	(11/18/96)		<5.0	

Quality Assurance

Reference	True Value (mg$CaCO_3$/L)	Result (mg$CaCO_3$/L)	% Recovery
ERA Minerals	120	114	95

Lot # 0725-96-11

Analyst

Approved

WORK RDER Summary

18-Nov-96

Repor ave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Client Pro D: 729691.32010

Phone: (303) 831-8100
FAX: (303) 831-8208

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-4058-01A	LF06-MPF-(4'-8')	% Moisture for dry weight calculation		Soil	2	15-Nov-96	16-Nov-96	03-Dec-96	13-Dec-96
96-4058-02A	LF06-MPF-(8'-10')	% Moisture for dry weight calculation						03-Dec-96	13-Dec-96
96-4058-03H	W79	Anions by IC Cl,NO2,NO3,SO4		Water	D5			03-Dec-96	17-Nov-96
96-4058-04H	W82	Anions by IC Cl,NO2,NO3,SO4						03-Dec-96	17-Nov-96
96-4058-05H	LF6-MPH	Anions by IC Cl,NO2,NO3,SO4						03-Dec-96	17-Nov-96
96-4058-06H	LF6-MPL	Anions by IC Cl,NO2,NO3,SO4						03-Dec-96	17-Nov-96
96-4058-07H	W18	Anions by IC Cl,NO2,NO3,SO4						03-Dec-96	17-Nov-96
96-4058-08H	LF6-MPK	Anions by IC Cl,NO2,NO3,SO4						03-Dec-96	17-Nov-96
96-4058-09H	LF6-MPI	Anions by IC Cl,NO2,NO3,SO4						03-Dec-96	17-Nov-96
96-4058-01A	LF06-MPF-(4'-8')	BTEX (Parsons List)		Soil	2			03-Dec-96	29-Nov-96
96-4058-02A	LF06-MPF-(8'-10')	BTEX (Parsons List)						03-Dec-96	29-Nov-96
96-4058-03A	W79	BTEX (Parsons List)		Water				03-Dec-96	29-Nov-96
96-4058-04A	W82	BTEX (Parsons List)						03-Dec-96	29-Nov-96
96-4058-05A	LF6-MPH	BTEX (Parsons List)						03-Dec-96	29-Nov-96
96-4058-06A	LF6-MPL	BTEX (Parsons List)						03-Dec-96	29-Nov-96
96-4058-07A	W18	BTEX (Parsons List)						03-Dec-96	29-Nov-96
96-4058-08A	LF6-MPK	BTEX (Parsons List)						03-Dec-96	29-Nov-96
96-4058-09A	LF6-MPI	BTEX (Parsons List)						03-Dec-96	29-Nov-96

# = Special list. See sample comments or test information.
HT = Holding Time expiration date.

PM 11/18/96

# = Special list. See sample comments or test information.
HT = Holding Time expiration date.

Evergreen Analytical, Inc.

96-4058

WORK ORDER Summary

18-Nov-96

Report To: Dave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Comments:

Client Project ID: 729691.32010

Phone: (303) 831-8100
FAX: (303) 831-8208

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-4058-04A	W82	TVH (Gasoline)		Water	2	15-Nov-96	16-Nov-96	03-Dec-96	29-Nov-96
96-4058-05A	LF6-MPH	TVH (Gasoline)						03-Dec-96	29-Nov-96
96-4058-06A	LF6-MPL	TVH (Gasoline)						03-Dec-96	29-Nov-96
96-4058-07A	W18	TVH (Gasoline)						03-Dec-96	29-Nov-96
96-4058-08A	LF6-MPK	TVH (Gasoline)						03-Dec-96	29-Nov-96
96-4058-09A	LF6-MPI	TVH (Gasoline)						03-Dec-96	29-Nov-96
96-4058-10A	Trip Blank	TVH (Gasoline)			9			03-Dec-96	29-Nov-96

CHAIN OF CUSTODY RECORD / A LYTICAL SERVICES REQUEST

1 of 1

Evergreen lytical Inc.
4036 Youngfield St.
Wheat Ridge, Colorado 80033
(303) 425-6021
FAX (303) 425-6854
(800) 845-7400

COMPANY arsons ES
ADDRESS 1700 Broadway, Ste 900
CITY Denver STATE CO ZIP 80290
PHONE# 303-813-8100 FAX # 303-831-8208 FAX RESULTS Y / N
Sampler Name:
(signature) Rob Nagel...
(print) Bruce Henry / Rob Nagel

CLIENT CONTACT (print) Jenny rtfelder
CLIENT PROJ. I.D. 729691.32010
EAL. QUOTE # ____ P.O.# 729691.32010
TURNAROUND REQUIRED* ☒ STD (2 wks) ☐ UST
☐ Other (Specify)*
*expedited turnaround subject to additional fee

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	Water-Drinking/Discharge/Ground (circle)	Soil / Solid / Air / Gas	Oil / Sludge / Multi-phase	TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle)	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	PCB Screen	Herbicides 8150/515 (circle)	BTEX 8020/602 (circle)/MTBE (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	Oil & Grease 413.1	TRPH 418.1	VOCs 8010	TOC	Anions (Cl, No₃, SO₄)	Methane			EAL use only
LF6-MPF-(4-8)'	11/15/96	1300	2		X									X						X	X						01 A/B Split
LF6-MPF-(8-10)'	11/15/96	1320	2		X									X						X	X						02 A/B Split
W79	11/15/96	745	11	X										X	X						X		X	X			03 A→K
W82	11/15/96	940	11	X										X	X						X		X	X			04
LF6-MPH	11/15/96	1100	11	X										X	X						X		X	X			05
LF6-MPL	11/15/96	1230	11	X										X	X						X		X	X			06
W118	11/15/96	1520	11	X										X	X						X		X	X			07
LF6-MPK	11/15/96	1545	12	X										X	X						X	X	X	X			08 A→L
LF6-MPT	11/15/96	1700	12	X										X	X						X	X	X	X			09 A→L
Trip Blank	11/15/96	1700	1	X										X	X						X			no			010 A
Sample Fraction														A						A	B	L	H	IJK			Loc D5,2,9
Instructions:														HW 40V							HUV	125 A	125 P	HUV			Cont

Analyze Trip Blank for 8010, 8020/8015M per Jenny Hartfelder 11/11/96

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
Rob Nagel...	11/15/96 1830	[signature]	11/16/96 0845				60

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report
Method Blank Report

Method Blank Number	: MB1111996	Client Project Number	: 729691.32010
Date Prepared	: 11/19/96	Lab Work Order	: 96-4058
Dilution Factor	: 1.0	Matrix	: Water
		Lab File Number	: TVB11118036

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/19/96	U	0.1	mg/L
Benzene	71-43-2	11/19/96	U	0.4	ug/L
Toluene	108-88-3	11/19/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/19/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/19/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/19/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/19/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/19/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/19/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/19/96	U	0.5	ug/L
FID Surrogate Recovery:		106%		50%-150%	(L[illegible])
PID Surrogate Recovery:		101%		50%-150%	([illegible])

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

H. Diane Mills
Analyst

P. McClelle
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report
Method Blank Report

Method Blank Number	: MB1112096	Client Project Number	: 729691.32010
Date Prepared	: 11/20/96	Lab Work Order	: 96-4058
Dilution Factor	: 1.0	Matrix	: Water
		Lab File Number	: TVB11120007

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/20/96	U	0.1	NA
Benzene	71-43-2	11/20/96	U	0.4	ug/L
Toluene	108-88-3	11/20/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/20/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/20/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/20/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/20/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/20/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/20/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/20/96	U	0.5	ug/L
FID Surrogate Recovery:		104%		50%-150%	(Limits)
Surrogate Recovery:		103%		50%-150%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report
Method Blank Report

Method Blank Number	: MB1112196	Client Project Number	: 729691.32010
Date Prepared	: 11/21/96	Lab Work Order	: 96-4058
Dilution Factor	: 1.0	Matrix	: Water
		Lab File Number	: TVB11120035

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	NA	NA	NA	NA
Benzene	71-43-2	11/21/96	U	0.4	ug/L
Toluene	108-88-3	11/21/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/21/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/21/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/21/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/21/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/21/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/21/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/21/96	U	0.5	ug/L
FID Surrogate Recovery:	NA			50%-150%	(Lin
PID Surrogate Recovery:		100%		50%-150%	(L

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

K. Hollman
Analyst

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Approved

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(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report
Method Blank Report

Method Blank Number	: MEB112096	Client Project Number	: 729691.32010
Date Prepared	: 11/20/96	Lab Work Order	: 96-4058
Dilution Factor	: 125	Matrix	: Water
		Lab File Number	: TVB11120008

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	NA	NA	NA	NA
Benzene	71-43-2	11/20/96	U	50	ug/L
Toluene	108-88-3	11/20/96	U	50	ug/L
Chlorobenzene	108-90-7	11/20/96	U	50	ug/L
Ethyl Benzene	100-41-4	11/20/96	U	50	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/20/96	U	50	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/20/96	U	50	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/20/96	U	50	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/20/96	U	50	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/20/96	U	63	ug/L
[illegible]ID Surrogate Recovery:	NA			50%-150%	(Limits)
[illegible]urrogate Recovery:		104%		50%-150%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

Analyst

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4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF06-MPF-(4-8)'	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4058-01	Lab Work Order	: 96-4058
Date Sampled	: 11/15/96	Matrix	: Soil
Date Received	: 11/16/96	Lab File Number(s)	: TVB11118050+
Date Prepared	: 11/19,20/96	Method Blank	: MB1111996+
FID Dilution Factor	: 5.0	Soil Extracted?	: YES
PID Dilution Factor	: 5.0, 125	Soil Moisture	: 34.94%

Compound Name	Cas Number	Analysis Date	Sample* Concentration	RL*	Units
TVH-Gasoline	----	NA	NA	NA	NA
Benzene	71-43-2	11/19/96	69	3.1	ug/kg
Toluene	108-88-3	11/19/96	10	3.1	ug/kg
Chlorobenzene	108-90-7	11/20/96	4900	77	ug/kg
Ethyl Benzene	100-41-4	11/19/96	84	3.1	ug/kg
Total Xylenes (m,p,o)	1330-20-7	11/19/96	210	3.1	ug/kg
1,3,5-Trimethylbenzene	108-67-8	11/19/96	89	3.1	ug/kg
1,2,4-Trimethylbenzene	95-63-6	11/19/96	240	3.1	ug/kg
1,2,3-Trimethylbenzene	526-73-8	11/19/96	110	3.1	ug/kg
1,2,3,4-Tetramethylbenzene	488-23-3	11/19/96	190	3.8	ug/kg
FID Surrogate Recovery:		NA		50%-150%	(L
PID Surrogate Recovery:		70%,109%		50%-150%	(L

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments: + = TVB11120009 and MEB112096.
* = Dry Basis

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

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Analyst

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Wheat Ridge, CO 80033
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SAMPLE Number : 96-4058-01
% WET SOIL : 34.94%
Dilution Factor : 5
Lab File No. :

Compound Name	Cas Number	SAMPLE Concentration ug/Kg	SAMPLE Concentration x *DILN*	SAMPLE CONC X % DRY x *DILN*
TVH-Gasoline	---		0.0	0.0
Benzene	71-43-2	8.973	44.9	69.0
Toluene	108-88-3	1.324	6.6	10.2
Chlorobenzene	108-90-7	288.231	1441.2	2215.1
Ethyl Benzene	100-41-4	10.875	54.4	83.6
m,p-Xylene	108-38-3 106-42-3	24.151	120.8	185.6
Xylene	95-47-6	3.416	17.1	26.3
TOTAL XYLENE			137.8	137.8
1,3,5-Trimethylbenzene	108-67-8	11.582	57.9	89.0
1,2,4-Trimethylbenzene	95-63-6	31.249	156.2	240.2
1,2,3-Trimethylbenzene	526-73-8	13.921	69.6	107.0
1,2,3,4-Tetramethylbenzene	488-23-3	24.999	192.1	192.1

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Wheat Ridge, CO 80033
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SAMPLE Number : 96-4058-01
% WET SOIL : 34.94%
Dilution Factor : 125
Lab File No. :

Compound Name	Cas Number	SAMPLE Concentration ug/Kg	SAMPLE CONC X % DRY
TVH-Gasoline	---		0.0
Benzene	71-43-2		0.0
Toluene	108-88-3		0.0
Chlorobenzene	108-90-7	3204.438	4925.4
Ethyl Benzene	100-41-4		0.0
m,p-Xylene	108-38-3 106-42-3		0.0
o-Xylene	95-47-6		0.0
TOTAL XYLENE			0.0
1,3,5-Trimethylbenzene	108-67-8		0.0
1,2,4-Trimethylbenzene	95-63-6		0.0
1,2,3-Trimethylbenzene	526-73-8		0.0
1,2,3,4-Tetramethylbenzene	488-23-3		0.0

EVERGREEN ANALYTICAL, INC.
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(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF06-MPF-(8-10)'	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4058-02	Lab Work Order	: 96-4058
Date Sampled	: 11/15/96	Matrix	: Soil
Date Received	: 11/16/96	Lab File Number(s)	: TVB11120058
Date Prepared	: 11/21/96	Method Blank	: MB1112196
FID Dilution Factor	: 1.0	Soil Extracted?	: NO
PID Dilution Factor	: 1.0	Soil Moisture	: 15.41%

Compound Name	Cas Number	Analysis Date	Sample* Concentration	RL*	Units
TVH-Gasoline	----	NA	NA	NA	NA
Benzene	71-43-2	11/21/96	U	0.5	ug/kg
Toluene	108-88-3	11/21/96	1.4	0.5	ug/kg
Chlorobenzene	108-90-7	11/21/96	0.7	0.5	ug/kg
Ethyl Benzene	100-41-4	11/21/96	U	0.5	ug/kg
Total Xylenes (m,p,o)	1330-20-7	11/21/96	U	0.5	ug/kg
1,3,5-Trimethylbenzene	108-67-8	11/21/96	U	0.5	ug/kg
1,2,4-Trimethylbenzene	95-63-6	11/21/96	U	0.5	ug/kg
1,2,3-Trimethylbenzene	526-73-8	11/21/96	U	0.5	ug/kg
1,2,3,4-Tetramethylbenzene	488-23-3	11/21/96	U	0.6	ug/kg
Surrogate Recovery:	NA			50%-150%	(Limits)
Surrogate Recovery:		75%		50%-150%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments: * = Dry Basis

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

K. Hillman
Analyst

P. McClelle
Approved

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Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: W79	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4058-03	Lab Work Order	: 96-4058
Date Sampled	: 11/15/96	Matrix	: Water
Date Received	: 11/16/96	Lab File Number(s)	: TVB11120010
Date Prepared	: 11/20/96	Method Blank	: MB1112096
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/20/96	U	0.1	mg/L
Benzene	71-43-2	11/20/96	U	0.4	ug/L
Toluene	108-88-3	11/20/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/20/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/20/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/20/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/20/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/20/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/20/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/20/96	U	0.5	ug/L
FID Surrogate Recovery:		103%		50%-150%	(L
PID Surrogate Recovery:		107%		50%-150%	(L

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

Analyst

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Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	:	W82	Client Project Number	:	729691.32010
Lab Sample Number	:	96-4058-04	Lab Work Order	:	96-4058
Date Sampled	:	11/15/96	Matrix	:	Water
Date Received	:	11/16/96	Lab File Number(s)	:	TVB11120017
Date Prepared	:	11/20/96	Method Blank	:	MB1112096
FID Dilution Factor	:	1.0			
PID Dilution Factor	:	1.0			

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/20/96	U	0.1	mg/L
Benzene	71-43-2	11/20/96	U	0.4	ug/L
Toluene	108-88-3	11/20/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/20/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/20/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/20/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/20/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/20/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/20/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/20/96	U	0.5	ug/L
D Surrogate Recovery:		97%		50%-150%	(Limits)
Surrogate Recovery:		97%		50%-150%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

Analyst

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(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF6-MPH	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4058-05	Lab Work Order	: 96-4058
Date Sampled	: 11/15/96	Matrix	: Water
Date Received	: 11/16/96	Lab File Number(s)	: TVB11120018
Date Prepared	: 11/20/96	Method Blank	: MB1112096
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/20/96	U	0.1	mg/L
Benzene	71-43-2	11/20/96	U	0.4	ug/L
Toluene	108-88-3	11/20/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/20/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/20/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/20/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/20/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/20/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/20/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/20/96	U	0.5	ug/L
FID Surrogate Recovery:		99%		50%-150%	(l…
PID Surrogate Recovery:		101%		50%-150%	(L…

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

Analyst

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4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF6-MPL	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4058-06	Lab Work Order	: 96-4058
Date Sampled	: 11/15/96	Matrix	: Water
Date Received	: 11/16/96	Lab File Number(s)	: TVB11120019
Date Prepared	: 11/20/96	Method Blank	: MB1112096
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/20/96	U	0.1	mg/L
Benzene	71-43-2	11/20/96	U	0.4	ug/L
Toluene	108-88-3	11/20/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/20/96	8.5	0.4	ug/L
Ethyl Benzene	100-41-4	11/20/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/20/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/20/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/20/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/20/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/20/96	U	0.5	ug/L
FID Surrogate Recovery:		102%		50%-150%	(Limits)
[illegible] Surrogate Recovery:		102%		50%-150%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

[signature]
Analyst

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(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: W18	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4058-07	Lab Work Order	: 96-4058
Date Sampled	: 11/15/96	Matrix	: Water
Date Received	: 11/16/96	Lab File Number(s)	: TVB11120020
Date Prepared	: 11/20/96	Method Blank	: MB1112096
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/20/96	U	0.1	mg/L
Benzene	71-43-2	11/20/96	1.3	0.4	ug/L
Toluene	108-88-3	11/20/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/20/96	22	0.4	ug/L
Ethyl Benzene	100-41-4	11/20/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/20/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/20/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/20/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/20/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/20/96	U	0.5	ug/L
FID Surrogate Recovery:		100%		50%-150%	(Li
PID Surrogate Recovery:		101%		50%-150%	(Li

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

Analyst

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4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF6-MPK	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4058-08	Lab Work Order	: 96-4058
Date Sampled	: 11/15/96	Matrix	: Water
Date Received	: 11/16/96	Lab File Number(s)	: TVB11120021
Date Prepared	: 11/20/96	Method Blank	: MB1112096
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/20/96	U	0.1	mg/L
Benzene	71-43-2	11/20/96	0.4	0.4	ug/L
Toluene	108-88-3	11/20/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/20/96	11	0.4	ug/L
Ethyl Benzene	100-41-4	11/20/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/20/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/20/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/20/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/20/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/20/96	U	0.5	ug/L
Surrogate Recovery:		94%		50%-150%	(Limits)
Surrogate Recovery:		96%		50%-150%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA =Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

Analyst

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF6-MPI	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4058-09	Lab Work Order	: 96-4058
Date Sampled	: 11/15/96	Matrix	: Water
Date Received	: 11/16/96	Lab File Number(s)	: TVB11120022
Date Prepared	: 11/20/96	Method Blank	: MB1112096
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/20/96	U	0.1	mg/L
Benzene	71-43-2	11/20/96	0.7	0.4	ug/L
Toluene	108-88-3	11/20/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/20/96	2.7	0.4	ug/L
Ethyl Benzene	100-41-4	11/20/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/20/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/20/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/20/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/20/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/20/96	U	0.5	ug/L
FID Surrogate Recovery:		97%		50%-150%	(Limits)
PID Surrogate Recovery:		98%		50%-150%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

Analyst

K. Hellman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: Trip Blank	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4058-10	Lab Work Order	: 96-4058
Date Sampled	: NA	Matrix	: Water
Date Received	: 11/16/96	Lab File Number(s)	: TVB11120023
Date Prepared	: 11/20/96	Method Blank	: MB1112096
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/20/96	U	0.1	mg/L
Benzene	71-43-2	11/20/96	U	0.4	ug/L
Toluene	108-88-3	11/20/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/20/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/20/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/20/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/20/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/20/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/20/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/20/96	U	0.5	ug/L
Surrogate Recovery:		98%		50%-150%	(Limits)
Surrogate Recovery:		100%		50%-150%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA =Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

Analyst

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EPA 602/8020 Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: LF06-MPF-(8-10)'	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4058-02	Lab Work Order	: 96-4058
Date Sampled	: 11/15/96	EPA Method No.	: 602/8020
Date Received	: 11/16/96	Matrix	: Soil
Date Prepared	: 11/19/96	Lab File Number(s)	: TVB11118054,55
Date Analyzed	: 11/19/96	Method Blank	: MB1111996
Instrument Name	: TVHBTEX1	Dilution Factor	: 1.0

Compound	Spike Added (ug/kg)	Sample Concentration (ug/kg)	Concentration (ug/kg)		Comments
			MS	MSD	
Benzene	20.0	0.0	18.5	16.6	
Toluene	20.0	1.1	18.2	16.4	
Chlorobenzene	20.0	0.6	18.4	16.4	
Ethylbenzene	20.0	0.0	17.7	16.0	
m,p-Xylene	20.0	0.0	17.1	15.4	
o-Xylene	20.0	0.0	17.2	15.5	
1,3,5-TMB	20.0	0.0	17.7	16.2	
1,2,4-TMB	20.0	0.0	17.1	15.9	
1,2,3-TMB	20.0	0.0	17.2	16.1	
1,2,3,4-TeMB	20.0	0.0	16.1	14.4	
Surrogate	100.0	75%	74%	76%	% RECOVERY

Compound		MS % RECOVERY	MSD % RECOVERY	RPD	QC# Limits RPD	QC# Limits %REC
Benzene		92.5	83.0	10.8	21	49 - 126
Toluene		85.5	76.5	11.1	25	46 - 131
Chlorobenzene		89.0	79.0	11.9	19	56 - 116
Ethylbenzene		88.5	80.0	10.1	25	35 - 133
m,p-Xylene		85.5	77.0	10.5	27	37 - 133
o-Xylene		86.0	77.5	10.4	27	37 - 131
1,3,5-TMB		88.5	81.0	8.8	24	48 - 123
1,2,4-TMB		85.5	79.5	7.3	23	43 - 125
1,2,3-TMB		86.0	80.5	6.6	23	44 - 123
1,2,3,4-TeMB		80.5	72.0	11.1	23	33 - 127
Surrogate		74.0	76.0	NA	NA	72 - 118

#= Limits extablished 10/1/96,HDM
*= Values outside of QC limits.

RPD: 0 out of (10) outside limits.
Spike Recovery: 0 out of (20) outside limits.

Comments:

K. Hellman
Analyst

P. McClell
Approved

Evergreen Analytical, Inc.
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EPA 602/8020 Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: W79	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4058-03	Lab Work Order	: 96-4058
Date Sampled	: 11/15/96	EPA Method No.	: 602/8020
Date Received	: 11/16/96	Matrix	: Water
Date Prepared	: 11/20/96	Lab File Number(s)	: TVB11120013,14
Date Analyzed	: 11/20/96	Method Blank	: MB1112096
Instrument Name	: TVHBTEX1	Dilution Factor	: 1.0

Compound	Spike Added (ug/L)	Sample Concentration (ug/L)	Concentration (ug/L)		Comments
			MS	MSD	
Benzene	20.0	0.0	19.4	19.9	
Toluene	20.0	0.0	18.8	19.3	
Chlorobenzene	20.0	0.0	18.6	19.4	
Ethylbenzene	20.0	0.0	18.8	19.5	
m,p-Xylene	20.0	0.0	18.5	19.0	
o-Xylene	20.0	0.0	18.9	19.2	
1,3,5-TMB	20.0	0.0	19.3	20.1	
1,2,4-TMB	20.0	0.0	19.0	19.4	
1,2,3-TMB	20.0	0.0	19.4	19.6	
1,2,3,4-TeMB	20.0	0.0	18.6	19.7	
Surrogate	100.0	107%	103%	103%	% RECOVERY

Compound		MS % RECOVERY	MSD % RECOVERY	RPD	QC# Limits		
					RPD	%REC	
Benzene		97.0	99.5	2.5	18	62 -	129
Toluene		94.0	96.5	2.6	25	55 -	133
Chlorobenzene		93.0	97.0	4.2	9	66 -	122
Ethylbenzene		94.0	97.5	3.7	15	60 -	127
m,p-Xylene		92.5	95.0	2.7	20	44 -	146
o-Xylene		94.5	96.0	1.6	16	57 -	131
1,3,5-TMB		96.5	100.5	4.1	16	63 -	129
1,2,4-TMB		95.0	97.0	2.1	16	55 -	136
1,2,3-TMB		97.0	98.0	1.0	13	64 -	127
1,2,3,4-TeMB		93.0	98.5	5.7	23	53 -	132
Surrogate		103.0	103.0	NA	NA	82 -	115

= Limits extablished 10/1/96,HDM
* = Values outside of QC limits.

RPD: 0 out of (10) outside limits.
Spike Recovery: 0 out of (20) outside limits.

Comments:

Analyst

K. Hillman
Approved

MSBTMB1;MSBW4058.XLS; 11/22/96

Evergreen Analytical, Inc.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
TVH Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: W79	Client Project No	: 729691.32010
Lab Sample No.	: 96-4058-03	Lab Work Order	: 96-4058
Date Sampled	: 11/15/96	EPA Method No.	: 5030/8015 Modified
Date Received	: 11/16/96	Matrix	: Water
Date Prepared	: 11/20/96	Lab File Number(s)	: TVB11120011,12
Date Analyzed	: 11/20/96	Method Blank	: MB1112096
Instrument Name	: TVHBTEX1	Dilution Factor	: 1.0

Compound	Spike Added (mg/L)	Sample Concentration (mg/L)	MS Concentration (mg/L)	MS %REC	QC (#) Limits %REC
Gasoline	2.00	0.00	1.92	96.0%	62 - 126
Surrogate **	---	---	---	109%	70 - 121

Compound	Spike Added (mg/L)	MSD Concentration (mg/L)	MSD %REC	RPD	QC (#) Limits	
					RPD	%RE
Gasoline	2.00	2.16	108.0%	11.8	42.3	62 - 126
Surrogate **	---	---	109%	NA	NA	70 - 121

RPD: 0 out of (1) outside limits.
Spike Recovery: 0 out of (2) outside limits.

Notes:
NA = Not analyzed/not applicable.
* = Values outside of QC limits.
** = 1,2,4-Trichlorobenzene
# = Limits established 10/2/96, KSH

Comments:

Analyst

K. Hellman
Approved

MSTVHWS1;MST14058.XLS; 11/22/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
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TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
Laboratory Control Sample (LCS)

LCS Number	: LCS1111996	Matrix	: Water
Date Prepared	: 11/19/96	Method Numbers	: EPA 5030/8015 Modified
Date Analyzed	: 11/19/96	Instrument Name	: TVHBTEX1
Lab File Number(s)	: TVB11118048		

Compound Name	Theoretical Concentration (mg/L)	LCS Concentration (mg/L)	LCS % Recovery	QC Limit % Recovery
Gasoline	2.00	2.12	106.0	83 - 120
Surrogate Recovery:		105%		70 - 121

QUALIFIERS

B = TVH as Gasoline found in blank also.
E = Extrapolated value. Value exceeds calibration range.
NA = Not Available/Not Applicable.
** = Limits established 9/24/96 for TVHBTEX1. HDM

H. Duane Mills
Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St.
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(303) 425-6021

EPA 602/8020 Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS1111996			
Date Extracted/Prepared	: 11/19/96	Dilution Factor	:	1.00
Date Analyzed	: 11/19/96	Method	:	602/8020
Spike Amount (ug/L)	: 20.0	Matrix	:	Water
		Lab File No.	:	TVB11118049

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit** % Recovery
Benzene	71-43-2	20.7	103.5	75 - 110
Toluene	108-88-3	19.7	98.5	75 - 110
Chlorobenzene	108-90-7	18.1	90.5	69 - 110
Ethyl Benzene	100-41-4	19.5	97.5	74 - 110
m,p-Xylene	108-38-3 106-42-3	37.2	93.0	73 - 110
o-Xylene	95-47-6	19.4	97.0	74 - [illegible]
MTBE	1634-04-4	19.7	98.5	59 - 129
1,3,5-Trimethylbenzene	108-67-8	20.0	100.0	70 - 110
1,2,4-Trimethylbenzene	95-63-6	18.4	92.0	73 - 110
1,2,3-Trimethylbenzene	526-73-8	22.3	111.5	84 - 122
1,2,3,4-Tetramethylbenzene	488-23-3	19.2	96.0	67 - 116
Surrogate Recovery:		100%		82 - 115

NOTES: m,p-xylene = 40.0 ppb spike.

QUALIFIERS:
E = Extrapolated value. Value exceeds that of the calibration range.
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
NA = Not available/Not analyzed.
** = Limits updated 10/02/96 for TVHBTEX1. SWT

K Hollman
Analyst

AmCall
Approved

EVERGREEN ANALYTICAL, INC.
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Wheat Ridge, CO 80033
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EPA 602/8020 Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS1112096	Dilution Factor	: 1.00
Date Extracted/Prepared	: 11/20/96	Method	: 602/8020
Date Analyzed	: 11/20/96	Matrix	: Water
Spike Amount (ug/L)	: 20.0	Lab File No.	: TVB11120006

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit** % Recovery
Benzene	71-43-2	20.9	104.5	75 - 110
Toluene	108-88-3	19.7	98.5	75 - 110
Chlorobenzene	108-90-7	20.2	101.0	69 - 110
Ethyl Benzene	100-41-4	20.3	101.5	74 - 110
m,p-Xylene	108-38-3 106-42-3	38.5	96.3	73 - 110
[illegible]Xylene	95-47-6	20.1	100.5	74 - 114
[illegible]	1634-04-4	18.2	91.0	59 - 129
1,3,5-Trimethylbenzene	108-67-8	21.3	106.5	70 - 110
1,2,4-Trimethylbenzene	95-63-6	19.2	96.0	73 - 110
1,2,3-Trimethylbenzene	526-73-8	24.2	121.0	84 - 122
1,2,3,4-Tetramethylbenzene	488-23-3	22.1	110.5	67 - 116
Surrogate Recovery:		105%		82 - 115

NOTES: m,p-xylene = 40.0 ppb spike.

QUALIFIERS:
E = Extrapolated value. Value exceeds that of the calibration range.
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
NA = Not available/Not analyzed.
** = Limits updated 10/02/96 for TVHBTEX1. SWT

[illegible]st

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
Laboratory Control Sample (LCS)

LCS Number	: LCS1112096	Matrix	: Water
Date Prepared	: 11/20/96	Method Numbers	: EPA 5030/8015 Modified
Date Analyzed	: 11/20/96	Instrument Name	: TVHBTEX1
Lab File Number(s)	: TVB11120005		

Compound Name	Theoretical Concentration (mg/L)	LCS Concentration (mg/L)	LCS % Recovery	QC Limit % Recovery
Gasoline	2.00	2.33	116.5	83 - 120
Surrogate Recovery:		110%		70 - 121

QUALIFIERS

B = TVH as Gasoline found in blank also.
E = Extrapolated value. Value exceeds calibration range.
NA = Not Available/Not Applicable.
** = Limits established 9/24/96 for TVHBTEX1. HDM

Analyst [signature]

Approved K. Hollman

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
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Method 601/8010 Chlorinated VOC's Method Blank Report

Method Blank	: RB112096	Client Project No.	: 729691.32010
Date Prepared	: 11/20/96	Lab Project No.	: 96-4058
Date Analyzed	: 11/20/96	Lab File No.	: HALL1120\004F0101

Compound	CAS #	Concentration (ug/L)	RL(ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 88% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4058.XLS; 11/27/96

EVERGREEN ANALYTICAL, INC.
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Method 8010 Chlorinated VOC's Method Blank Report

Method Blank	: RB112196	Client Project No.	: 729691.32010
Date Prepared	: 11/21/96	Lab Project No.	: 96-4058
Date Analyzed	: 11/21/96	Lab File No.	: HALL1121\004F0101

Compound	CAS #	Concentration (ug/L)	RL(ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.4
1,1,2,2-Tetrachloroethane	79-34-5	U	0.42
2-Chlorotoluene	95-49-8	U	0.54
4-Chlorotoluene	106-49-8	U	0 [illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	U	[illegible]

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 81% 70% - 130% (QC limits)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4058.XLS; 11/27/96

EVERGREEN ANALYTICAL, INC.
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(303) 425-6021

Method 601/8010 Chlorinated VOC's Method Blank Report

Method Blank	:	MB112696	Client Project No.	:	729691.32010
Date Prepared	:	11/26/96	Lab Project No.	:	96-4058
Date Analyzed	:	11/26/96	Lab File No.	:	HALL1126\004F0101

Compound	CAS #	Concentration (ug/L)	RL(ug/L)
Chlorobenzene	108-90-7	U	0.42

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 87% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES: ______

Analyst

Approved

HLW4058.XLS; 11/27/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF06-MPF-(4'-8')	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4058-01	Lab Project No.	: 96-4058
Date Sampled	: 11/15/96	Matrix	: Soil
Date Received	: 11/16/96	Lab File No.	: HALL1120\017F0101
Date Prepared	: 11/20/96	Method Blank	: RB112096
Date Analyzed	: 11/20/96	Dilution Factor	: 1.6
Percent Moisture	: 34.94		

Compound	CAS #	Concentration(ug/Kg)	RL(ug/Kg)
Vinyl Chloride	75-01-4	U	0.63
Chloroethane	75-00-3	U	0.63
1,1-Dichloroethene	75-35-4	U	0.63
Dichloromethane	75-09-2	U	0.63
trans-1,2-Dichloroethene	156-60-5	U	0.63
1,1-Dichloroethane	75-34-3	U	0.63
cis-1,2-Dichloroethene	156-59-4	U	0.63
1,1,1-Trichloroethane	71-55-6	U	0.63
Carbon Tetrachloride	56-23-5	U	0.63
Trichloroethene	79-01-6	U	0.63
1,1,2-Trichloroethane	79-00-5	U	0.63
Tetrachloroethene	127-18-4	U	0.63
1,1,1,2-Tetrachloroethane	79-00-5	U	0.63
Chlorobenzene	108-90-7	E	0.66
1,1,2,2-Tetrachloroethane	79-34-5	U	0.84
2-Chlorotoluene	95-49-8	U	0.63
4-Chlorotoluene	106-49-8	U	0.63
1,3-Dichlorobenzene	541-73-1	12	0.63
1,2-Dichlorobenzene	95-50-1	7.7	0.63

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 95% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4058.XLS; 12/3/96

QUANT REPORT Page 1

Operator ID: [illegible] Quant [illegible]: [illegible] [illegible]: [illegible]
Output File: ^[illegible]287::Q1 Quantitated at: [illegible] 18:[illegible]
Data File: [illegible]287::S1 Dilution Factor: 1.00000
Name: 92-4078-01 [illegible] Instrument ID: VOA 1
Misc: 9;5;5.02;1;5;0;11/21/92;0

ID File: ID_024::Q[illegible]
Title: ID FILE FOR APPENDIX NINE VOAs METHOD 8240[illegible]
Last Calibration: 921120 10:56 Last Qcal Time: <none>

	Compound	R.T.	Scan#	Area	Conc	Units	q
1)	*BROMOCHLOROMETHANE(INT STD)	6.12	[illegible]	28[illegible]4	50.00	UG/L	82
[illegible])	METHYLENE CHLORIDE	2.92	[illegible]	1[illegible]	1.22	UG/L	[illegible]
[illegible])	1,2-DICHLOROETHANE-D4(SUR STD)	[illegible]	[illegible]	61[illegible]	48.14	UG/L	10[illegible]
[illegible])	*1,4-DIFLUOROBENZENE(INT STD)	8.62	8[illegible]4	115[illegible]11	50.00	UG/L	100
[illegible])	*CHLOROBENZENE-D5(INTERNAL STD)	14.46	1[illegible]	[illegible]	50.00	UG/L	100
[illegible])	TOLUENE-D8(SURROGATE STD)	11.[illegible]	112[illegible]	112[illegible]4	61.35	UG/L	100
[illegible])	CHLOROBENZENE	14.53	14[illegible]	448[illegible]	3[illegible]35.99	UG/L	100
[illegible])	BROMOFLUOROBENZENE(SURR STD)	1[illegible].07	1[illegible]5	60503	61.44	UG/L	100
[illegible])	1,3-DICHLOROBENZENE	19.38	1917	5976 M	44.70	UG/L	9[illegible]
[illegible])	1,2-DICHLOROBENZENE	20.37	2012	20019	15.53	UG/L	77
[illegible])	1,4-DICHLOROBENZENE	19.61	1949	149[illegible]2	[illegible]05.98	UG/L	[illegible]

* Compound is ISTD

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF06-MPF-(4'-8')	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4058-01	Lab Project No.	: 96-4058
Date Sampled	: 11/15/96	Matrix	: Soil
Date Received	: 11/16/96	Lab File No.	: HALL1126\008F0101
Date Prepared	: 11/26/96	Method Blank	: MB112696
Date Analyzed	: 11/26/96	Dilution Factor	: 191.2
Percent Moisture	: 34.94		

Compound	CAS #	Concentration(ug/Kg)	RL(ug/Kg)
Chlorobenzene	108-90-7	1300	80

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 96% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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HLW4058.XLS; 11/27/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	:	LF06-MPF-(8'-10')	Client Project No.	:	729691.32010
Lab Sample No.	:	96-4058-02	Lab Project No.	:	96-4058
Date Sampled	:	11/15/96	Matrix	:	Soil
Date Received	:	11/16/96	Lab File No.	:	HALL1120\015F0101
Date Prepared	:	11/20/96	Method Blank	:	RB112096
Date Analyzed	:	11/20/96	Dilution Factor	:	1.2
Percent Moisture	:	15.41			

Compound	CAS #	Concentration(ug/Kg)	RL(ug/Kg)
Vinyl Chloride	75-01-4	1.7 J X	0.47
Chloroethane	75-00-3	U	0.47
1,1-Dichloroethene	75-35-4	U	0.47
Dichloromethane	75-09-2	0.89 J X	0.47
trans-1,2-Dichloroethene	156-60-5	U	0.47
1,1-Dichloroethane	75-34-3	U	0.47
cis-1,2-Dichloroethene	156-59-4	U	0.47
1,1,1-Trichloroethane	71-55-6	U	0.47
Carbon Tetrachloride	56-23-5	U	0.47
Trichloroethene	79-01-6	U	0.47
1,1,2-Trichloroethane	79-00-5	U	0.47
Tetrachloroethene	127-18-4	U	0.47
1,1,1,2-Tetrachloroethane	79-00-5	U	0.47
Chlorobenzene	108-90-7	2 J	0.49
1,1,2,2-Tetrachloroethane	79-34-5	U	0.63
2-Chlorotoluene	95-49-8	U	0.47
4-Chlorotoluene	106-49-8	U	0.47
1,3-Dichlorobenzene	541-73-1	U	0.47
1,2-Dichlorobenzene	95-50-1	U	0.47

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 97% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES: X = Not confirmed by MS (MDL = 1ug/Kg).

Analyst

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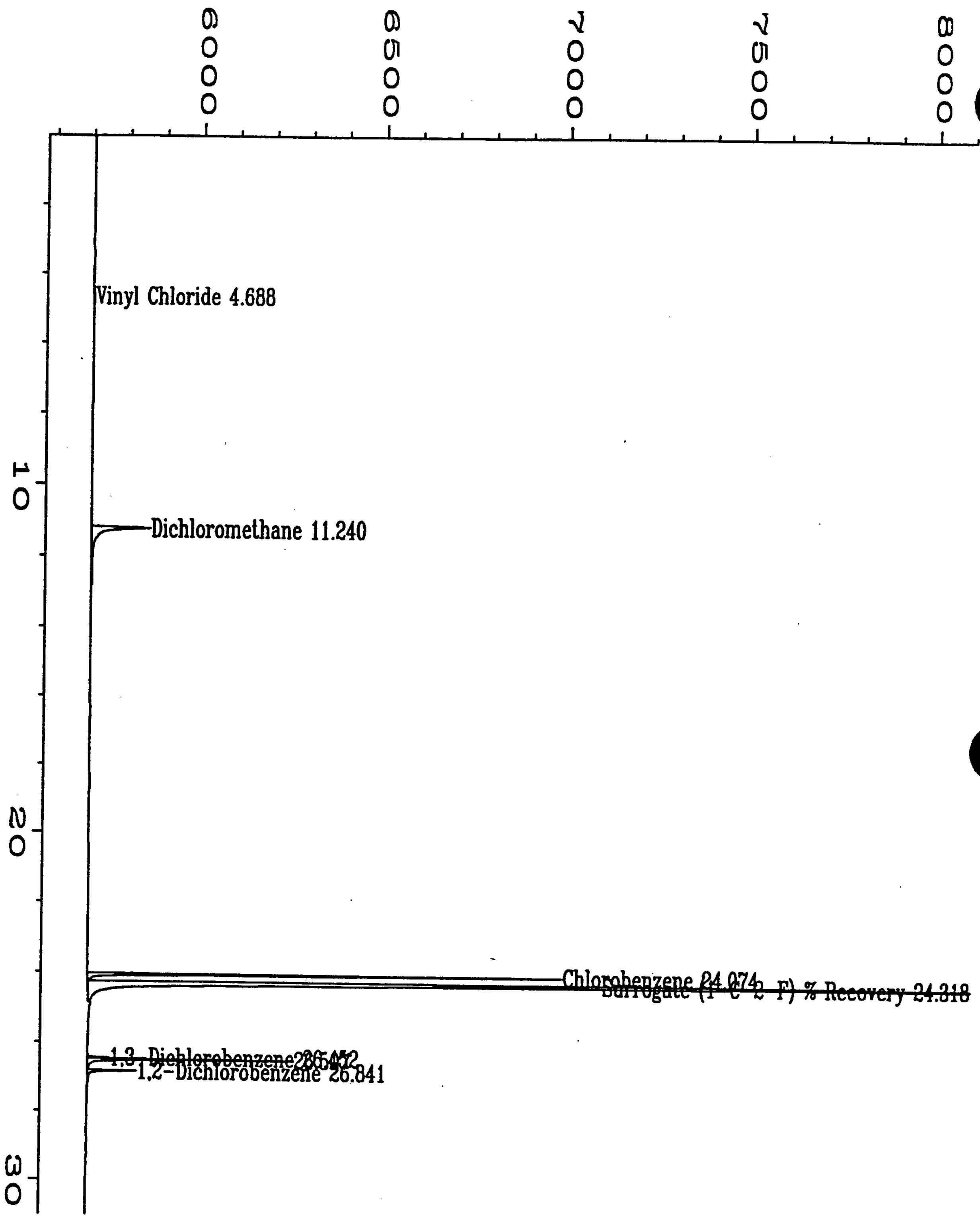
HLW4058.XLS; 12/5/96



Data File Name : C:\HPCHEM\1\DATA\hall1120\015F0101.D
Operator : John Parker
Instrument : HALL
Sample Name : 96-4058-02B
Run Time Bar Code:
Acquired on : 20 Nov 96 05:55 PM
Report Created on: 20 Nov 96 06:26 PM
Last Recalib on : 18 NOV 96 05:47 PM
Multiplier : 1
Sample Info : SAMP 8010_S
::5.06g LF06-MPF-(8'-10')

Page Number : 1
Vial Number : 15
Injection Number : 1
Sequence Line : 1
Instrument Method: PES11
Analysis Method : PES11 T
Sample Amount : 0
ISTD Amount :

QUANT REPORT

Operator ID: KIM
Output File: ^V2947::Q1
Data File: >V2947::V2
Name: RB112796 ;;;KL
Misc: 5;W;0;1;W;0;11/27/96;0

Quant Rev: 7 Quant Time: 961127 10:59
Injected at: 961127 10:34
Dilution Factor: 1.00000
Instrument ID: VOA 1

ID File: ID_824::QT
Title: ID FILE FOR APPENDIX NINE VOAs METHOD 8260A(8240)
Last Calibration: 961125 12:35 Last Qcal Time: <none>

	Compound	R.T.	Scan#	Area	Conc	Units	q
1)	*BROMOCHLOROMETHANE(INT STD)	6.14	584	37231M	50.00	UG/L	76
4)	BROMOMETHANE	1.29	94	1518	2.16	UG/L	100
23)	1,2 DICHLOROETHANE-D4(SUR STD)	7.45	716	87087	50.49	UG/L	100
24)	*1,4 DIFLUOROBENZENE(INT STD)	8.60	832	174566	50.00	UG/L	100
46)	*CHLOROBENZENE-D5(INTERNAL STD)	14.42	1419	144891	50.00	UG/L	100
53)	TOLUENE-D8(SURROGATE STD)	11.50	1124	182569	49.38	UG/L	100
58)	BROMOFLUOROBENZENE(SURR STD)	17.04	1683	95316	47.23	UG/L	100

* Compound is ISTD

QUANT REPORT

Operator ID: KIM
Output File: ^V2958::Q1
Data File: >V2958::V2
Name: 96-4058-02 ;;;KL
Misc: 5;S;5.01;1;S;0;11/27/96;0

Quant Rev: 7
Quant Time: 961127 16:04
Injected at: 961127 15:39
Dilution Factor: 1.00000
Instrument ID: VOA 1

ID File: ID_824::Q1
Title: ID FILE FOR APPENDIX NINE VOAs METHOD 8260A(8240)
Last Calibration: 961125 12:35
Last Qcal Time: <none>

	Compound	R.T.	Scan#	Area	Conc	Units	q
1)	*BROMOCHLOROMETHANE(INT STD)	6.10	579	31481	50.00	UG/L	7[illegible]
4)	BROMOMETHANE	1.27	92	875	1.47	UG/L	10[illegible]
23)	1,2 DICHLOROETHANE-D4(SUR STD)	7.43	714	75078	51.47	UG/L	10[illegible]
24)	*1,4 DIFLUOROBENZENE(INT STD)	8.58	830	170251	50.00	UG/L	10[illegible]
46)	*CHLOROBENZENE-D5(INTERNAL STD)	14.41	1418	139638	50.00	UG/L	10[illegible]
53)	TOLUENE-D8(SURROGATE STD)	11.48	1122	180579	50.68	UG/L	10[illegible]
55)	CHLOROBENZENE	14.47	1424	4147	1.44	UG/L	10[illegible]
58)	BROMOFLUOROBENZENE(SURR STD)	17.04	1683	91009	46.79	UG/L	10[illegible]
64)	1,4-DICHLOROBENZENE	19.61	1942	1412	.555	UG/L	9[illegible]

* Compound is ISTD

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: W79	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4058-03	Lab Project No.	: 96-4058
Date Sampled	: 11/15/96	Matrix	: Water
Date Received	: 11/16/96	Lab File No.	: HALL1120\027F0101
Date Prepared	: 11/20/96	Method Blank	: RB112096
Date Analyzed	: 11/21/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
[illegible]hlorotoluene	106-49-8	U	0.4
[illegible]3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 81% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4058.XLS; 11/27/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	:	W82	Client Project No.	:	729691.32010
Lab Sample No.	:	96-4058-04	Lab Project No.	:	96-4058
Date Sampled	:	11/15/96	Matrix	:	Water
Date Received	:	11/16/96	Lab File No.	:	HALL1121\006F0101
Date Prepared	:	11/21/96	Method Blank	:	RB112196
Date Analyzed	:	11/21/96	Dilution Factor	:	1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	1.4	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	0.73 J	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	[illegible]
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 84% 70% - 130% (QC limits)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF6-MPH	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4058-05	Lab Project No.	: 96-4058
Date Sampled	: 11/15/96	Matrix	: Water
Date Received	: 11/16/96	Lab File No.	: HALL1121\007F0101
Date Prepared	: 11/21/96	Method Blank	: RB112196
Date Analyzed	: 11/21/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 80% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF6-MPL	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4058-06	Lab Project No.	: 96-4058
Date Sampled	: 11/15/96	Matrix	: Water
Date Received	: 11/16/96	Lab File No.	: HALL1121\008F0101
Date Prepared	: 11/21/96	Method Blank	: RB112196
Date Analyzed	: 11/21/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	2.1 J	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	3.7	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	[illegible]
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 79% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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HLW4058.XLS; 12/5/96

QUANT REPORT

Operator ID: KIM | Quant Rev: 7 | Quant Time: 961121 17:51
Output File: ^V2885::Q1 | Injected at: 961121 17:27
Data File: >V2885::S1 | Dilution Factor: 1.00000
Name: 96-4082-06 ;;;KL | Instrument ID: VOA 1
Misc: 5;W;0;1;W;0;11/21/96;0

ID File: ID_824::Q1
Title: ID FILE FOR APPENDIX NINE VOAs METHOD 8260A(8240
Last Calibration: 961120 10:56 Last Qcal Time: <none>

	Compound	R.T.	Scan#	Area	Conc	Units	q
1)	*BROMOCHLOROMETHANE(INT STD)	6.17	587	35283	50.00	UG/L	82
5)	VINYL CHLORIDE	.98	63	4911	3.58	UG/L	100
23)	1,2 DICHLOROETHANE-D4(SUR STD)	7.50	721	83665	46.52	UG/L	100
24)	*1,4 DIFLUOROBENZENE(INT STD)	8.64	836	175557	50.00	UG/L	100
46)	*CHLOROBENZENE-D5(INTERNAL STD)	14.45	1422	146181	50.00	UG/L	100
53)	TOLUENE-D8(SURROGATE STD)	11.52	1126	184089	48.26	UG/L	100
55)	CHLOROBENZENE	14.50	1427	27233	8.86	UG/L	100
58)	BROMOFLUOROBENZENE(SURR STD)	17.06	1685	100846	49.24	UG/L	100
64)	1,4-DICHLOROBENZENE	19.60	1941	31161	10.60	UG/L	97

* Compound is ISTD

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: W18	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4058-07	Lab Project No.	: 96-4058
Date Sampled	: 11/15/96	Matrix	: Water
Date Received	: 11/16/96	Lab File No.	: HALL1121\009F0101
Date Prepared	: 1[illegible]/21/96	Method Blank	: RB112196
Date Analyzed	: 11/21/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	4.9	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	1.3	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	13	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	0.78 J	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 90% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4058.XLS; 11/27/96

QUANT REPORT

Operator ID: KIM
Output File: ^V2888::Q1
Data File: >V2888::S1
Name: 96-4058-07 ;;;KL
Misc: 5;W;0;1;W;0;11/21/96;0

Quant Rev: 7
Quant Time: 961122 04:30
Injected at: 961121 19:02
Dilution Factor: 1.00000
Instrument ID: VOA 1

ID File: ID_824::QT
Title: ID FILE FOR APPENDIX NINE VOAs METHOD 8260A(8240)
Last Calibration: 961120 10:56
Last Qcal Time: <none>

	Compound	R.T.	Scan#	Area	Conc	Units	q
1)	*BROMOCHLOROMETHANE(INT STD)	6.18	587	35466	50.00	UG/L	98
4)	BROMOMETHANE	1.29	94	677	.997	UG/L	100
5)	VINYL CHLORIDE	.98	63	11576	8.39	UG/L	100
17)	1,1 DICHLOROETHANE	4.17	385	3730M	1.40	UG/L	100
19)	CIS 1,2-DICHLOROETHENE	5.64	533	2834M	2.15	UG/L	39
23)	1,2 DICHLOROETHANE-D4(SUR STD)	7.48	718	84528	46.75	UG/L	100
24)	*1,4 DIFLUOROBENZENE(INT STD)	8.62	833	172245	50.00	UG/L	100
46)	*CHLOROBENZENE-D5(INTERNAL STD)	14.42	1418	143780	50.00	UG/L	100
53)	TOLUENE-D8(SURROGATE STD)	11.48	1122	179533	47.85	UG/L	100
55)	CHLOROBENZENE	14.47	1423	73220	24.21	UG/L	100
58)	BROMOFLUOROBENZENE(SURR STD)	17.04	1683	95978	47.64	UG/L	100
63)	1,2-DICHLOROBENZENE	20.40	2021	2612	.990	UG/L	96
64)	1,4-DICHLOROBENZENE	19.60	1941	36364	12.58	UG/L	95

* Compound is ISTD

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF6-MPK	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4058-08	Lab Project No.	: 96-4058
Date Sampled	: 11/15/96	Matrix	: Water
Date Received	: 11/16/96	Lab File No.	: HALL1121\010F0101
Date Prepared	: 11/21/96	Method Blank	: RB112196
Date Analyzed	: 11/21/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	3	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	6.1	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	0.55 J	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 85% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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QUANT REPORT

Page 1

[illegible]tor ID: KIM
Output File: ^V2889::Q1
Data File: >V2889::S1
Name: 96-4058-08 ;;;KL
Misc: 5;W;0;1;W;0;11/21/96;0

Quant Rev: 7 Quant Time: 961122 04:3[illegible]
Injected at: 961121 19:36
Dilution Factor: 1.00000
Instrument ID: VOA 1

ID File: ID_824::W1
Title: ID FILE FOR APPENDIX NINE VOAs METHOD 8260A(8240)
Last Calibration: 961120 10:56 Last Qcal Time: <none>

	Compound	R.T.	Scan#	Area	Conc	Units	Q
1)	*BROMOCHLOROMETHANE(INT STD)	6.12	582	37284	50.00	UG/L	78
4)	BROMOMETHANE	1.29	94	723	.999	UG/L	100
5)	VINYL CHLORIDE	.97	62	7686	5.23	UG/L	100
23)	1,2 DICHLOROETHANE-D4(SUR STD)	7.45	716	91270	47.38	UG/L	100
24)	*1,4 DIFLUOROBENZENE(INT STD)	8.61	833	188208	50.00	UG/L	100
46)	*CHLOROBENZENE-D5(INTERNAL STD)	14.44	1421	156166	50.00	UG/L	100
53)	TOLUENE-D8(SURROGATE STD)	11.50	1124	195768	48.04	UG/L	100
55)	CHLOROBENZENE	14.49	1426	38454	11.71	UG/L	100
58)	BROMOFLUOROBENZENE(SURR STD)	17.06	1685	108572	49.62	UG/L	100
63)	1,2-DICHLOROBENZENE	20.38	2020	2592	.905	UG/L	99
64)	1,4-DICHLOROBENZENE	19.61	1942	36981	11.78	UG/L	96

* Compound is ISTD

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF6-MPI	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4058-09	Lab Project No.	: 96-4058
Date Sampled	: 11/15/96	Matrix	: Water
Date Received	: 11/16/96	Lab File No.	: HALL1121\011F0101
Date Prepared	: 11/21/96	Method Blank	: RB112196
Date Analyzed	: 11/21/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	3.4	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	1.8	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 78% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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HLW4058.XLS; 11/27/96

QUANT REPORT   Page 1

Operator ID: KIM   Quant Rev: 7   Quant Time: 961122 04:51
Output File: ^V2890::Q1   Injected at: 961121 20:03
Data File: >V2890::S1   Dilution Factor: 1.00000
Name: 96-4058-09 ;;;KL   Instrument ID: VOA 1
Misc: 5;W;0;1;W;0;11/21/96;0

ID File: ID_824::QT
Title: ID FILE FOR APPENDIX NINE VOAs METHOD 8260A(8240)
Last Calibration: 961120 10:56   Last Qcal Time: <none>

	Compound	R.T.	Scan#	Area	Conc	Units	q
1)	*BROMOCHLOROMETHANE(INT STD)	6.15	585	36383	50.00	UG/L	82
5)	VINYL CHLORIDE	.98	63	8448M	5.97	UG/L	100
11)	METHYLENE CHLORIDE	2.91	258	1863	1.54	UG/L	4[illegible]
17)	1,1 DICHLOROETHANE	4.16	384	1740M	.638	UG/L	100
19)	CIS 1,2-DICHLOROETHENE	5.62	531	4014M	2.97	UG/L	79
23)	1,2 DICHLOROETHANE-D4(SUR STD)	7.47	718	86695	46.74	UG/L	100
24)	*1,4 DIFLUOROBENZENE(INT STD)	8.62	834	184480	50.00	UG/L	100
46)	*CHLOROBENZENE-D5(INTERNAL STD)	14.43	1420	154115	50.00	UG/L	100
53)	TOLUENE-D8(SURROGATE STD)	11.50	1124	191515	47.62	UG/L	100
55)	CHLOROBENZENE	14.48	1425	5258	1.78	UG/L	100
58)	BROMOFLUOROBENZENE(SURR STD)	17.04	1683	101581	47.04	UG/L	100
64)	1,4-DICHLOROBENZENE	19.62	1943	3904	1.26	UG/L	8[illegible]

* Compound is ISTD

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: Trip Blank	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4058-10	Lab Project No.	: 96-4058
Date Sampled	: 11/15/96	Matrix	: Water
Date Received	: 11/16/96	Lab File No.	: HALL1121\012F0101
Date Prepared	: 11/21/96	Method Blank	: RB112196
Date Analyzed	: 11/21/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	[illegible]
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 79% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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HLW4058.XLS; 11/27/96

Method 8010 [illegible]y Control Samples

Date Performed: 11/25/96 Reference Standard: V832

Analyte	M	Method Blank	Sample 96-4058-03	Sample Spike	Spike Dup.	Control Spike	Spike Amt	RPD	Spike Recoveries Sample	Dup	#	Control	#	QC Recovery Range % L - % H	Low - High
Vinyl Chloride	w			13.191	15.032	12.340	20.0	13.0	66%	75%		62%		28 - 163	5.60 - 32.60
Chloroethane	*			16.194	17.032	15.169	20.0	5.0	81%	85%		76%		46 - 137	9.20 - 27.40
1,1-Dichloroethene	*			16.112	16.76	14.989	20.0	3.9	81%	84%		75%		28 - 167	5.60 - 33.40
Dichloromethane	*			16.801	17.482	15.865	20.0	4.0	84%	87%		79%		25 - 162	5.00 - 32.40
trans-1,2-Dichloroethene	*			20.911	20.811	19.097	20.0	0.5	105%	104%		95%		38 - 155	7.60 - 31.00
1,1-Dichloroethane	*			18.785	18.88	17.713	20.0	0.5	94%	94%		89%		47 - 132	9.40 - 26.40
cis-1,2-Dichloroethene	*			19.488	20.232	18.452	20.0	3.7	97%	101%		92%		-	-
1,1,1-Trichloroethane	*			18.376	18.544	16.660	20.0	0.9	92%	93%		83%		41 - 138	8.20 - 27.60
Carbon Tetrachloride	*			17.987	18.527	16.088	20.0	3.0	90%	93%		80%		43 - 143	8.60 - 28.60
Trichloroethene	w			19.481	19.07	17.880	20.0	2.1	97%	95%		89%		35 - 146	7.00 - 29.20
1,1,2-Trichloroethane	w			19.915	19.583	20.053	20.0	1.7	100%	98%		100%		39 - 136	7.80 - 27.20
Tetrachloroethene	*			17.637	18.829	16.415	20.0	6.5	88%	94%		82%		26 - 162	5.20 - 32.40
1,1,1,2-Tetrachloroethane	*			18.314	17.533	16.920	20.0	4.4	92%	88%		85%		-	-
Chlorobenzene	*			19.02	20.754	17.551	20.0	8.7	95%	104%		88%		1 - 150	0.16 - 30.00
1,1,2,2-Tetrachloroethane	*			22.817	22.364	22.618	20.0	2.0	114%	112%		113%		8 - 184	1.60 - 36.80
2-Chlorotoluene	*			18.084	17.97	15.986	20.0	0.6	90%	90%		80%		-	-
4-Chlorotoluene	*			16.707	16.978	16.326	20.0	1.6	84%	85%		82%		-	-
1,3-Dichlorobenzene	*			17.433	17.065	16.047	20.0	2.1	87%	85%		80%		7 - 187	1.40 - 37.40
1,2-Dichlorobenzene	*			16.638	15.715	14.815	20.0	5.7	83%	79%		74%		0 - 208	0.00 - 41.60

M = Applicable matrices. (* = Soil and Water. w = Water only.)

= Marks a spike recovery out of limits.
If recovery is outside method limit, marked with "*".
If recovery is outside a guideline, marked with "~".
If the sample spike recovery is outside the limit and the control spike is outside the limit also, the control is marked with "**" or "~~".

Notes on recovery limits:
All spiked analytes must be detected even if low limit is 0.
For analytes not listed in the method, recovery limits of 50-150% will be used as guidelines until limits can be established.

Corrective Actions:
Unacceptable sample spike recovery requires acceptable control spike recovery. If both recoveries are outside limits, corrective action must be taken. One recovery outside limits and the other acceptable, is a warning. Repeated failure requires corrective action. Recoveries outside guidelines should be compared to historical data available to determine if corrective action is required.

HLW4058.XLS; 11/27/96

Method 8010 Quality Control Samples

Date Performed: 11/26/96

Reference Standard: V832

Analyte	M	Method Blank	Sample 96-4058-01	Sample Spike	Spike Dup.	Control Spike	Spike Amt	RPD	Spike Recoveries Sample	Dup	#	Control	#	QC Recovery Range %L - %H	Low - High
Vinyl Chloride	w			18.934	18.194	15.379	20.0	4.0	95%	91%		77%		28 - 163	5.60 - 32.60
Chloroethane	*			15.887	16.059	17.891	20.0	1.1	79%	80%		89%		46 - 137	9.20 - 27.40
1,1-Dichloroethene	*			17.573	17.773	17.127	20.0	1.1	88%	89%		86%		28 - 167	5.60 - 33.40
Dichloromethane	*			18.685	18.774	17.583	20.0	0.5	93%	94%		88%		25 - 162	5.00 - 32.40
trans-1,2-Dichloroethene	*			17.578	20.624	21.135	20.0	15.9	88%	103%		106%		38 - 155	7.60 - 31.00
1,1-Dichloroethane	*			19.601	18.302	19.074	20.0	6.9	98%	92%		95%		47 - 132	9.40 - 26.40
cis-1,2-Dichloroethene	*			20.569	18.868	18.995	20.0	8.6	103%	94%		95%		-	-
1,1,1-Trichloroethane	*			19.451	19.065	18.147	20.0	2.0	97%	95%		91%		41 - 138	8.20 - 27.60
Carbon Tetrachloride	*			19.807	19.25	18.101	20.0	2.9	99%	96%		91%		43 - 143	8.60 - 28.60
Trichloroethene	w			22.269	21.621	19.084	20.0	3.0	111%	108%		95%		35 - 146	7.00 - 29.20
1,1,2-Trichloroethane	w			22.311	23.451	20.830	20.0	5.0	112%	117%		104%		39 - 136	7.80 - 27.20
Tetrachloroethene	*			19.595	19.624	18.384	20.0	0.1	98%	98%		92%		26 - 162	5.20 - 32.40
1,1,1,2-Tetrachloroethane	*			18.985	18.834	18.317	20.0	0.8	95%	94%		92%		-	-
Chlorobenzene	*		6.614	32.611	31.901	18.708	20.0	2.8	130%	126%		94%		1 - 150	0.16 - 30.00
1,1,2,2-Tetrachloroethane	*			22.215	22.98	21.958	20.0	3.4	111%	115%		110%		8 - 184	1.60 - 36.80
2-Chlorotoluene	*			17.424	17.669	17.857	20.0	1.4	87%	88%		89%		-	-
4-Chlorotoluene	*			17.104	16.936	17.091	20.0	1.0	86%	85%		85%		-	-
1,3-Dichlorobenzene	*		0.063	17.327	16.541	16.205	20.0	4.7	86%	82%		81%		7 - 187	1.40 - 37.40
1,2-Dichlorobenzene	*		0.082	14.577	14.405	16.967	20.0	1.2	72%	72%		85%		0 - 208	0.00 - 41.60

M = Applicable matrices. (* = Soil and Water. w = Water only.)

= Marks a spike recovery out of limits.
If recovery is outside method limit, marked with "*".
If recovery is outside a guideline, marked with "~".
If the sample spike recovery is outside the limit and the control spike is outside the limit also, the control is marked with "**" or "~~".

Notes on recovery limits:
All spiked analytes must be detected even if low limit is 0.
For analytes not listed in the method, recovery limits of 50-150% will be used as guidelines until limits can be established.

Corrective Actions:
Unacceptable sample spike recovery requires acceptable control spike recovery. If both recoveries are outside limits, corrective action must [illegible]n. One recovery outside limits and the other acceptable, is [illegible]. Repeated failure requires corrective action. Reco[illegible]utside guidelines should be compared to historical data avai[illegible] determine if corrective action is required.

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form
Method Blank Report

Method Blank Number	: GB112296	Client Project No.	: 729691.32010
Date Extracted/Prepared	: 11/22/96	Lab Work Order	: 96-4058
Date Analyzed	: 11/22/96	Dilution Factor	: 1.00
		Method	: RSKSOP-175M
		Matrix	: Water
		Lab File No.	: GAS1122002

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
\ = Not Available/Not Applicable.

Analyst

K. Hellman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: W79	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4058-03	Lab Work Order	: 96-4058
Date Sampled	: 11/15/96	Dilution Factor	: 1.00
Date Received	: 11/16/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/22/96	Matrix	: Water
Date Analyzed	: 11/22/96	Lab File No.	: GAS1122011

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Temperature	:	76.3 F
Amount Injected	:	0.5 ml
Total Volume of Sample	:	43 ml
Head space created	:	4 ml
Methane Area	:	0 ug
Atomic weight(Methane)	:	16 g

Saturation Concentration	Meth	
Concentration in Head Space	Meth	

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Hellman
Approved

AF4058.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: W82	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4058-04	Lab Work Order	: 96-4058
Date Sampled	: 11/15/96	Dilution Factor	: 1.00
Date Received	: 11/16/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/22/96	Matrix	: Water
Date Analyzed	: 11/22/96	Lab File No.	: GAS1122012

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

erature	:	75.9 F
nt Injected	:	0.5 ml
Total Volume of Sample	:	43 ml
Head space created	:	4 ml
Methane Area	:	0 ug
Atomic weight(Methane)	:	16 g

Saturation Concentration	Meth	0
Concentration in Head Space	Meth	0

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
'A = Not Available/Not Applicable.

Analyst

Approved

AF4058.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: LF6-MPH	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4058-05	Lab Work Order	: 96-4058
Date Sampled	: 11/15/96	Dilution Factor	: 1.00
Date Received	: 11/16/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/22/96	Matrix	: Water
Date Analyzed	: 11/22/96	Lab File No.	: GAS1122013

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Temperature	: 75.8 F	Saturation Concentration	Meth	
Amount Injected	: 0.5 ml	Concentration in Head Space	Meth	
Total Volume of Sample	: 43 ml			
Head space created	: 4 ml			
Methane Area	: 0 ug			

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: LF6-MPL	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4058-06	Lab Work Order	: 96-4058
Date Sampled	: 11/15/96	Dilution Factor	: 10.00
Date Received	: 11/16/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/22/96	Matrix	: Water
Date Analyzed	: 11/22/96	Lab File No.	: GAS1122014

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.21	0.02

erature	: 75.8 F	Saturation Concentration	Meth	0.050843483
nt Injected	: 0.05 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.159059193
Head space created	: 4 ml			
Methane Area	: 118.234 ug			

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
'A =Not Available/Not Applicable.

Analyst

K. Hollman
Approved

AF4058.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: LF6-MPL	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4058-06Dup	Lab Work Order	: 96-4058
Date Sampled	: 11/15/96	Dilution Factor	: 10.00
Date Received	: 11/16/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/22/96	Matrix	: Water
Date Analyzed	: 11/22/96	Lab File No.	: GAS1122015

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.21	0.02

Temperature	:	75.8 F
Amount Injected	:	0.05 ml
Total Volume of Sample	:	43 ml
Head space created	:	4 ml
Methane Area	:	117.254 ug

Saturation Concentration	Meth	0.050[illegible]
Concentration in Head Space	Meth	0.1577408

Atomic weight(Methane)	:	16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Hillman
Approved

AF4058.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: W18	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4058-07	Lab Work Order	: 96-4058
Date Sampled	: 11/15/96	Dilution Factor	: 1.00
Date Received	: 11/16/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/22/96	Matrix	: Water
Date Analyzed	: 11/22/96	Lab File No.	: GAS1122016

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.110	0.002

rature	: 75.7 F	Saturation Concentration	Meth	0.02669457
A nt Injected	: 0.5 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.083527131
Head space created	: 4 ml			
Methane Area	: 620.769 ug			

Atomic weight(Methane) : 16 g

Qualifiers

E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
A =Not Available/Not Applicable.

Analyst

K. Hollman
Approved

AF4058.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: LF6-MPK	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4058-08	Lab Work Order	: 96-4058
Date Sampled	: 11/15/96	Dilution Factor	: 10.00
Date Received	: 11/16/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/22/96	Matrix	: Water
Date Analyzed	: 11/22/96	Lab File No.	: GAS1122017

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.22	0.02

Temperature	:	75.8 F
Amount Injected	:	0.05 ml
Total Volume of Sample	:	43 ml
Head space created	:	4 ml
Methane Area	:	121.6 ug
Atomic weight(Methane)	:	16 g

Saturation Concentration	Meth	0.052
Concentration in Head Space	Meth	0.16358744

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Hollman
Approved

AF4058.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: LF6-MPI	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4058-09	Lab Work Order	: 96-4058
Date Sampled	: 11/15/96	Dilution Factor	: 10.00
Date Received	: 11/16/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/22/96	Matrix	: Water
Date Analyzed	: 11/22/96	Lab File No.	: GAS1122019

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.26	0.02

erature	:	76.3 F	Saturation Concentration	Meth	0.062608945
nt Injected	:	0.05 ml			
Total Volume of Sample	:	43 ml	Concentration in Head Space	Meth	0.195683554
Head space created	:	4 ml			
Methane Area	:	145.594 ug			
Atomic weight(Methane)	:	16 g			

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Hollman
Approved

AF4058.XLS

Evergreen Analytical, Inc.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

RSKSOP-175M Gas Method
Methane Gas Matrix Spike / Matrix Spike Duplicate Report

Client Sample No.	: LF6-MPH	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4058-05	Lab Work Order	: 96-4058
Date Sampled	: 11/15/96	EPA Method No.	: RSKSOP-175M
Date Received	: 11/16/96	Matrix	: Water
Date Prepared	: 11/22/96	Method Blank	: GB112296
Date Analyzed	: 11/22/96	Lab File No's.	: GAS1122020,021
E.A. MS/MSD Spike Source No.	: 1886		

Compound	Spike Added (ug)	Sample Concentration (ug)	MS Concentration (ug)	MS %REC	QC Limits %REC
Methane Gas	500	0	426	85	47-88

Compound	Spike Added (ug)	MSD Concentration (ug)	MSD %REC	RPD	QC Limits RPD	QC Limits %REC
Methane Gas	500	430	86	0.9	0-16.4	47-88

RPD: 0 out of (1) outside limits.
Spike Recovery: 0 out of (2) outside limits.

Notes
* = Values outside of QC limits.
NA = Not analyzed/not available

Note: The Spike was made by taking the sample and displacing 4ml of headspace with a 1% methane gas and shaking the VOA for 5 minutes. Then injecting 50 ul from the headspace into the GC resulting in a theoretical concentration of 500 ug.

[illegible signature]
Analyst

K. Hallman
Approved

Evergreen Analytical, Inc.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

RSKSOP-175M Gas Method
Methane LCS Report Form

LCS No.	: LCS112296	EPA Method No.	: RSKSOP-175M
Date Prepared	: 11/22/96	Matrix	: Water
Date Analyzed	: 11/22/96	Method Blank	: GB112296
E.A. LCS Source No.	: 1886	Lab File No.	: GAS1122009

Compound	Spike Added (ug)	Method Blank Concentration (ug)	LCS Concentration (ug)	LCS %REC	QC Limits %REC
Methane Gas	500	0	417	83	64-90

Spike Recovery: 0 out of (1) outside limits.

Note: The LCS was made by taking the sample and displacing 4ml of headspace with a 1% methane gas and shaking the VOA for 5 minutes. Then injecting 50 ul from the headspace into the GC resulting in a theoretical concentration of 500 ug.

Notes
* = Values outside of QC limits.
NA = Not analyzed/not available.

Analyst

K. Hollman
Approved

LCS1122.XLS; 11/25/96

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/15/96		Client Project ID.	:	729691.32010
Date Received	: 11/16/96		Lab Project Number	:	96-4058
Date Prepared	: 11/16/96		Method	:	EPA 300.0
Date Analyzed	: 11/16/96		Detection Limit	:	0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Chloride mg/L	Dilution Factor
96-4058-03	W79	Water	3.7	1
96-4058-03 Duplicate	W79 Duplicate	Water	3.7	1
96-4058-04	W82	Water	5.5	1
96-4058-05	LF6-MPH	Water	3.9	1
96-4058-06	LF6-MPL	Water	11.3	1
96-4058-07	W18	Water	16.8	1
96-4058-08	LF6-MPK	Water	18.9	1
96-4058-09	LF6-MPI	Water	51.2	10
Method Blank	(11/16/96)	Water	<0.25	1

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4058-03	W79 Matrix Spike	10.0	3.7	14.1	103
96-4058-03	W79 Matrix Spike Dup	10.0	3.7	14.4	106
MS/MSD RPD					2.9

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.

4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/15/96	Client Project ID.	: 729691.32010
Date Received	: 11/16/96	Lab Project Number	: 96-4058
Date Prepared	: 11/16/96	Method	: EPA 300.0
Date Analyzed	: 11/16/96	Detection Limit	: 0.076 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrite-N mg/L	Dilution Factor
96-4058-03	W79	Water	<0.076	1
96-4058-03 Duplicate	W79 Duplicate	Water	<0.076	1
96-4058-04	W82	Water	<0.076	1
96-4058-05	LF6-MPH	Water	<0.076	1
96-4058-06	LF6-MPL	Water	<0.076	1
96-4058-07	W18	Water	<0.076	1
96-4058-08	LF6-MPK	Water	<0.076	1
96-4058-09	LF6-MPI	Water	<0.076	1
Method Blank	(11/16/96)	Water	<0.076	1

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4058	W79 Matrix Spike	10.0	<0.25	9.7	97
96-4058	W79 Matrix Spike Dup	10.0	<0.25	9.6	96
MS/MSD RPD					0.7

* = Quality assurance results reported as Nitrite (NO_2).

Jeff Hal
Analyst

Approved

EVERGREEN ANALYTICAL, Inc.

4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/15/96		Client Project ID.	:	729691.32010
Date Received	: 11/16/96		Lab Project Number	:	96-4058
Date Prepared	: 11/16/96		Method	:	EPA 300.0
Date Analyzed	: 11/16/96		Detection Limit	:	0.056 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrate-N mg/L	Dilution Factor
96-4058-03	W79	Water	1.4	1
96-4058-03 Duplicate	W79 Duplicate	Water	1.4	1
96-4058-04	W82	Water	1.9	1
96-4058-05	LF6-MPH	Water	0.61	1
96-4058-06	LF6-MPL	Water	<0.056	1
96-4058-07	W18	Water	<0.056	1
96-4058-08	LF6-MPK	Water	<0.056	1
96-4058-09	LF6-MPI	Water	<0.056	1
Method Blank	(11/16/96)	Water	<0.056	1

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4058-03	W79 Matrix Spike	10.0	6.2	16.0	98
96-4058-03	W79 Matrix Spike Dup	10.0	6.2	16.0	98
MS/MSD RPD					0.6

* = Quality assurance results reported as Nitrate (NO_3).

Jeff Hal
Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	:	11/15/96	Client Project ID.	:	729691.32010
Date Received	:	11/16/96	Lab Project Number	:	96-4058
Date Prepared	:	11/16/96	Method	:	EPA 300.0
Date Analyzed	:	11/16/96	Detection Limit	:	0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Sulfate mg/L	Dilution Factor
96-4058-03	W79	Water	1.3	1
96-4058-03 Duplicate	W79 Duplicate	Water	1.3	1
96-4058-04	W82	Water	1.5	1
96-4058-05	LF6-MPH	Water	14.9	1
96-4058-06	LF6-MPL	Water	5.6	1
96-4058-07	W18	Water	8.9	1
96-4058-08	LF6-MPK	Water	3.7	1
96-4058-09	LF6-MPI	Water	1.4	1
Method Blank	(11/16/96)	Water	<0.25	1

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4058-03	W79 Matrix Spike	10.0	1.3	10.5	92
96-4058-03	W79 Matrix Spike Dup	10.0	1.3	10.4	91
MS/MSD RPD					1.4

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Total Recoverable Petroleum Hydrocarbons

Date Sampled	: 11/15/96	Client Project ID.	: 729691.32010
Date Received	: 11/16/96	Lab Project Number	: 96-4058
Date Prepared	: 11/19/96	Method	: EPA 418.1
Date Analyzed	: 11/19/96		

Evergreen Sample #	Client Sample ID.	Matrix	TRPH	Units
96-4058-01	LF-06-MPF-(4-8)'	Soil	760	mg/Kg
96-4058-02	LF06-MPF-(8-10)'	Soil	<3.9	mg/Kg
96-4058-02 Duplicate	LF06-MPF-(8-10)' Duplicate	Soil	<3.9	mg/Kg

Method Blank (11/19/96) Subtracted	4.9	mg/Kg

Results calculated on a dry weight basis.

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Total Organic Carbon

Date Sampled	: 11/15/96	Client Project ID.	: 729691.32010
Date Received	: 11/16/96	Lab Project Number	: 96-4058
Date Prepared	: 11/25/96	Method	: EPA 415.1
Date Analyzed	: 11/25/96	Detection Limit	: 1.0 mg C/L

Evergreen Sample #	Client Sample ID.	Matrix	TOC mg C/L	Dilution Factor
96-4058-08	LF6-MPK	Water	5.6	1
96-4058-08 Duplicate	LF6-MPK Duplicate	Water	5.9	1
96-4058-09	LF6-MPI	Water	<1.0	1
Method Blank	(11/25/96)		<1.0	

Quality Assurance

		Spike Amount (mgC/L)	Sample Result (mgC/L)	Spike Result (mgC/L)	% Recovery
96-4058-08	LF6-MPK Matrix Spike	10.0	5.6	16.6	110
96-4058	LF6-MPK Matrix Spike Dup	10.0	5.6	16.2	105
MS/MSD RPD					3.8

Analyst

Approved

Ev[illegible]een Analytical, Inc.

96-4064

WORK ORDER Summary

20-Nov-96

Report To: Dave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Client Project ID: 729691.32010

Phone: (303) 831-8100
FAX: (303) 831-8208

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-4064-01K	LF6-MPN	Anions by IC Cl,NO2,NO3,SO4		Water	CR3	17-Nov-96	18-Nov-96	03-Dec-96	19-Nov-96
96-4064-02K	LF6-MPC(S)	Anions by IC Cl,NO2,NO3,SO4						03-Dec-96	19-Nov-96
96-4064-03K	LF6-MPC(D)	Anions by IC Cl,NO2,NO3,SO4						03-Dec-96	19-Nov-96
96-4064-04K	LF6-MPJ	Anions by IC Cl,NO2,NO3,SO4						03-Dec-96	19-Nov-96
96-4064-05K	LF6-MPA(S)	Anions by IC Cl,NO2,NO3,SO4						03-Dec-96	19-Nov-96
96-4064-06K	LF6-MPA(D)	Anions by IC Cl,NO2,NO3,SO4						03-Dec-96	19-Nov-96
96-4064-07K	LF06-MW19	Anions by IC Cl,NO2,NO3,SO4						03-Dec-96	19-Nov-96
96-4064-08K	LF06-MPR	Anions by IC Cl,NO2,NO3,SO4						03-Dec-96	19-Nov-96
96-4064-09K	LF06-MPD(D)	Anions by IC Cl,NO2,NO3,SO4						03-Dec-96	19-Nov-96
96-4064-10K	LF06-MPF(D)	Anions by IC Cl,NO2,NO3,SO4						03-Dec-96	19-Nov-96
96-4064-01D	LF6-MPN	BTEX Parsons			2			03-Dec-96	01-Dec-96
96-4064-02D	LF6-MPC(S)	BTEX Parsons						03-Dec-96	01-Dec-96
96-4064-03D	LF6-MPC(D)	BTEX Parsons						03-Dec-96	01-Dec-96
96-4064-04D	LF6-MPJ	BTEX Parsons						03-Dec-96	01-Dec-96
96-4064-05D	LF6-MPA(S)	BTEX Parsons						03-Dec-96	01-Dec-96
96-4064-06D	LF6-MPA(D)	BTEX Parsons						03-Dec-96	01-Dec-96

# = Special list. See sample comments or test information.
HT = Holding Time expiration date.

PM 11/21/96

Evergreen Analytical, Inc. 96-4064

WORK ORDER Summary

20-Nov-96

Report To: Dave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Client Project ID: 729691.32010

Phone: (303) 831-8100
FAX: (303) 831-8208

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-4064-07D	LF06-MW19	BTEX Parsons		Water	2	17-Nov-96	18-Nov-96	03-Dec-96	01-Dec-96
96-4064-08D	LF06-MPR	BTEX Parsons						03-Dec-96	01-Dec-96
96-4064-09D	LF06-MPD(D)	BTEX Parsons						03-Dec-96	01-Dec-96
96-4064-10D	LF06-MPF(D)	BTEX Parsons						03-Dec-96	01-Dec-96
96-4064-01H	LF6-MPN	Methane						03-Dec-96	01-Dec-96
96-4064-02H	LF6-MPC(S)	Methane						03-Dec-96	01-Dec-96
96-4064-03H	LF6-MPC(D)	Methane						03-Dec-96	01-Dec-96
96-4064-04H	LF6-MPJ	Methane						03-Dec-96	01-Dec-96
96-4064-05H	LF6-MPA(S)	Methane						03-Dec-96	01-Dec-96
96-4064-06H	LF6-MPA(D)	Methane						03-Dec-96	01-Dec-96
96-4064-07H	LF06-MW19	Methane						03-Dec-96	01-Dec-96
96-4064-08H	LF06-MPR	Methane						03-Dec-96	01-Dec-96
96-4064-09H	LF06-MPD(D)	Methane						03-Dec-96	01-Dec-96
96-4064-10H	LF06-MPF(D)	Methane						03-Dec-96	01-Dec-96
96-4064-01A	LF6-MPN	Purgeable Halocarbons 8010			9			03-Dec-96	01-Dec-96
96-4064-02A	LF6-MPC(S)	Purgeable Halocarbons 8010						03-Dec-96	01-Dec-96
96-4064-03A	LF6-MPC(D)	Purgeable Halocarbons 8010						03-Dec-96	01-Dec-96
96-4064-04A	LF6-MPJ	Purgeable Halocarbons 8010						03-Dec-96	01-Dec-96
96-4064-05A	LF6-MPA(S)	Purgeable Halocarbons 8010						03-Dec-96	01-Dec-96
96-4064-06A	LF6-MPA(D)	Purgeable Halocarbons 8010						03-Dec-96	01-Dec-96
96-4064-07A	LF06-MW19	Purgeable Halocarbons 8010						03-Dec-96	01-Dec-96
96-4064-08A	LF06-MPR	Purgeable Halocarbons 8010						03-Dec-96	01-Dec-96
96-4064-09A	LF06-MPD(D)	Purgeable Halocarbons 8010						03-Dec-96	01-Dec-96

# = Sp[illegible] See sample comments or test information.
HT = [illegible] Time expiration date.

Evergreen Analytical, Inc.

WORK ORDER Summary

21-Nov-96

Report To: Dave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Client Project ID: 729691.32010

Phone: (303) 831-8100
FAX: (303) 831-8208

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-4064-10A	LF06-MPF(D)	Purgeable Halocarbons 8010		Water	9	17-Nov-96	18-Nov-96	03-Dec-96	01-Dec-96
96-4064-11A	Trip Blank #7	Purgeable Halocarbons 8010						03-Dec-96	01-Dec-96
96-4064-01D	LF6-MPN	TVH (Gasoline)			2			03-Dec-96	01-Dec-96
96-4064-02D	LF6-MPC(S)	TVH (Gasoline)						03-Dec-96	01-Dec-96
96-4064-03D	LF6-MPC(D)	TVH (Gasoline)						03-Dec-96	01-Dec-96
96-4064-04D	LF6-MPJ	TVH (Gasoline)						03-Dec-96	01-Dec-96
96-4064-05D	LF6-MPA(S)	TVH (Gasoline)						03-Dec-96	01-Dec-96
96-4064-06D	LF6-MPA(D)	TVH (Gasoline)						03-Dec-96	01-Dec-96
96-4064-07D	LF06-MW19	TVH (Gasoline)						03-Dec-96	01-Dec-96
96-4064-08D	LF06-MPR	TVH (Gasoline)						03-Dec-96	01-Dec-96
96-4064-09D	LF06-MPD(D)	TVH (Gasoline)						03-Dec-96	01-Dec-96
96-4064-10D	LF06-MPF(D)	TVH (Gasoline)						03-Dec-96	01-Dec-96

# = Special list. See sample comments or test information.
HT = Holding Time expiration date.

CHAIN OF CUSTODY RECORD / ANALYTICAL SERVICES REQUEST

Evergreen Analytical Inc.
4036 Youngfield St.
Wheat Ridge, Colorado 80033
(303) 425-6021
FAX (303) 425-6854
(800) 845-7400

COMPANY Parsons ES
ADDRESS 1700 Broadway, Ste 900
CITY Denver STATE CO ZIP 80290
PHONE# (303) 831-8100 FAX # (303) 831-8208 FAX RESULTS Y / N

Sampler Name:
(signature) Rob Nagel
(print) Rob Nagel Bruce Henry

CLIENT CONTACT (print) Jenny Hartfelder
CLIENT PROJ. I.D. 729691.32010
EAL. QUOTE # P.O.# 729691.32010
TURNAROUND REQUIRED* ☒ STD (2 wks) ☐ UST
☐ Other (Specify)*
*expedited turnaround subject to additional fee

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	Water-Drinking/Discharge/Ground (circle)	Soil / Solid / Air / Gas	Oil / Sludge / Multi-phase	TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle) 8010 pm	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	PCB Screen	Herbicides 8150/515 (circle)	BTEX 8020/602 (circle)/MTBE (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	Oil & Grease 413.1	TRPH 418.1	Methane GC404	Anions (Cl, NO2, NO3, SO4)	EAL use only
LF6-MPN	11/17/96	715	11	X				X						X	X						X	X	01 A-K
LF6-MPC(S)	11/17/96	845	11	X				X						X	X						X	X	02
LF6-MPC(D)	11/17/96	1015	11	X				X						X	X						X	X	03
LF6-MPJ	11/17/96	1300	11	X				X						X	X						X	X	04
LF6-MPA(S)	11/17/96	1530	11	X				X						X	X						X	X	05
LF6-MPA(D)	11/17/96	1645	11	X				X						X	X						X	X	06
LF06-MW19	11/17/96	1050	11	X				X						X	X						X	X	07
LF06-MPR	11/17/96	1300	11	X				X						X	X						X	X	08
LF06-MPD(D)	11/17/96	1410	11	X				X						X	X						X	X	09
LF06-MPF(D)	11/17/96	1650	11	X				X						X	X						X	X	10
Sample Fraction								ABC						DE	FG						HIJ	K	Loc 40V, 125P
Instructions:																							Cont 11, 2, CR3

EAL use only
Do not write in shaded area
W.O. # 96-4064
B.O.F. #
C/S (O) 396
C/S (I) 396
Cooler Temp. °C 3
Seals Intact Y N / NA
Samples Pres. Y N NA
Headspace Y N NA

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
[signature]	11/18/96					[signature]	11/18/96

CHAIN OF CUSTODY RECORD / A[redacted]ALYTICAL SERVICES REQUEST

Evergree[redacted]alytical Inc.
4036 Youngfield St.
Wheat Ridge, Colorado 80033
(303) 425-6021
FAX (303) 425-6854
(800) 845-7400

COMPANY [redacted] Parsons ES
ADDRESS 1700 Broadway, Ste 900
CITY Denver STATE CO ZIP 80290
PHONE# (303) 851-8100 FAX # (303) 851-8208 FAX RESULTS Y / N

Sampler Name:
(signature) Bruce Henry
(print) Rob Nagel / Bruce Henry

CLIENT CONTACT (print) Jenny H[redacted]elder
CLIENT PROJ. I.D. 729691.32010
EAL. QUOTE # ______ P.O.# 729691.32010
TURNAROUND REQUIRED* ☒ STD (2 wks) ☐ UST
☐ Other (Specify)* ______
*expedited turnaround subject to additional fee

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	Soil / Solid / Air / Gas	Oil / Sludge / Multi-phase	ANALYSIS REQUESTED: TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle) 8010	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	PCB Screen	Herbicides 8150/515 (circle)	BTEX 8020/602 (circle)/MTBE (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	Oil & Grease 413.1	TRPH 418.1	EAL use only. Do not write in shaded area. W.O. # ___ B.O.F. # ___ C/S (O) ___/___ C/S (I) ___/___ Cooler Temp. °C ___ Seals Intact Y / N / NA Samples Pres. Y / N / NA Headspace Y / N / NA
TRIP BLANK #7	11/17/96	–	1					X													11 AB
Sample Fraction																					Loc MDV
Instructions:																					Cont

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
Bruce Henry 11/18/96 5:30AM						[signature]	11/18/96 1:50

ASA

ATLANTIC SOUTHEAST AIRLINES, INC.

SHIPPERS DECLARATION OF NON-INFECTIOUS SUBSTANCES

The United States Department of Transportation (DOT) has adopted by reference the IATA/ICAO (49 CFR) Dangerous Goods Regulations.

These regulations address infectious substances as follows:

Infectious Substances (Division 6.2)

3.6.6 "Infectious substances" are defined as those substances containing viable micro-organisms or their toxins which are known, or suspected, to cause disease in animals or humans.

NOTE 1: "Biological products" and "Diagnostic specimens" are not considered to be dangerous goods provided they do not contain, or are reasonably believed not to contain, an infectious substance, or do not contain any other dangerous substance.

NOTE 2: Any substance containing acquired immune deficiency syndrome virus (AIDS), suspected of containing AIDS, or being transported for diagnostic analysis for AIDS is considered as an infectious substance for the purposes of these Regulations.

"Diagnostic specimens" are any human or animal material including, but not limited to, excreta, secreta, blood and its components, tissue and tissue fluids, being shipped for purposes of diagnosis, but excluding live infected animals.

C108

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w0108

I certify that this shipment is not of an infectious nature nor is it being transported for the testing of infectious substances as defined in this declaration.

DATE 11/18/96

NAME Rob Nagel

(Please Print)

COMPANY NAME Parsons Engineering Science

SIGNATURE Rob Nagel

AIR WAYBILL NUMBER 862 GTR 62973945

DISTRIBUTION: ORIGINAL - Origin Station copy of Air Waybill
COPY 2 - Attached to Delivery Receipt
COPY 3 - Shipper.

AC-0025
2-1-89

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report
Method Blank Report

Method Blank Number	: MB2112196	Client Project Number	: 729691.32010
Date Prepared	: 11/21/96	Lab Work Order	: 96-4064
Dilution Factor	: 1.0	Matrix	: WATER
		Lab File Number	: TVB21120028

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/21/96	U	0.1	mg/L
Benzene	71-43-2	11/21/96	U	0.4	ug/L
Toluene	108-88-3	11/21/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/21/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/21/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/21/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/21/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/21/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/21/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/21/96	U	0.5	ug/L
FID Surrogate Recovery:		81%		70%-126%	(Limits)
[illegible] Surrogate Recovery:		91%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Blecha
Analyst

K Hollman
Approved

TVBXWS2P;TV24064P.XLS; 11/25/96; 1

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report
Method Blank Report

Method Blank Number	: MB211.2296	Client Project Number	: 729691.32010
Date Prepared	: 11/22/96	Lab Work Order	: 96-4064
Dilution Factor	: 1.0	Matrix	: WATER
		Lab File Number	: TVB21120061

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/22/96	U	0.1	mg/L
Benzene	71-43-2	11/22/96	U	0.4	ug/L
Toluene	108-88-3	11/22/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/22/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/22/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/22/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/22/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/22/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/22/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/22/96	U	0.5	ug/L
FID Surrogate Recovery:		87%		70%-126%	(Li
PID Surrogate Recovery:		94%		76%-127%	(L

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

Analyst

K Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF6-MPN	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4064-01	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	Matrix	: WATER
Date Received	: 11/18/96	Lab File Number(s)	: TVB21120036
Date Prepared	: 11/21/96	Method Blank	: MB2112196
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/21/96	U	0.1	mg/L
Benzene	71-43-2	11/21/96	1.6	0.4	ug/L
Toluene	108-88-3	11/21/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/21/96	35	0.4	ug/L
Ethyl Benzene	100-41-4	11/21/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/21/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/21/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/21/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/21/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/21/96	U	0.5	ug/L
Surrogate Recovery:		107%		70%-126%	(Limits)
Surrogate Recovery:		106%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

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U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Blacho
Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF6-MPC(S)	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4064-02	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	Matrix	: WATER
Date Received	: 11/18/96	Lab File Number(s)	: TVB21120037
Date Prepared	: 11/21/96	Method Blank	: MB2112196
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/21/96	U	0.1	mg/L
Benzene	71-43-2	11/21/96	1.8	0.4	ug/L
Toluene	108-88-3	11/21/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/21/96	21	0.4	ug/L
Ethyl Benzene	100-41-4	11/21/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/21/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/21/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/21/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/21/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/21/96	U	0.5	ug/l
FID Surrogate Recovery:		95%		70%-126%	(Li
PID Surrogate Recovery:		105%		76%-127%	(Lim

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	:	LF6-MPC(D)	Client Project Number	:	729691.32010
Lab Sample Number	:	96-4064-03	Lab Work Order	:	96-4064
Date Sampled	:	11/17/96	Matrix	:	WATER
Date Received	:	11/18/96	Lab File Number(s)	:	TVB21120062
Date Prepared	:	11/22/96	Method Blank	:	MB2112296
FID Dilution Factor	:	1.0			
PID Dilution Factor	:	1.0			

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/22/96	U	0.1	mg/L
Benzene	71-43-2	11/22/96	1.8	0.4	ug/L
Toluene	108-88-3	11/22/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/22/96	5.0	0.4	ug/L
Ethyl Benzene	100-41-4	11/22/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/22/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/22/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/22/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/22/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/22/96	U	0.5	ug/L
Surrogate Recovery:		96%		70%-126%	(Limits)
Surrogate Recovery:		98%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

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U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF6-MPJ	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4064-04	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	Matrix	: WATER
Date Received	: 11/18/96	Lab File Number(s)	: TVB21120039
Date Prepared	: 11/21/96	Method Blank	: MB2112196
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/21/96	U	0.1	mg/L
Benzene	71-43-2	11/21/96	U	0.4	ug/L
Toluene	108-88-3	11/21/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/21/96	1.1	0.4	ug/L
Ethyl Benzene	100-41-4	11/21/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/21/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/21/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/21/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/21/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/21/96	U	0.5	ug/L
FID Surrogate Recovery:		93%		70%-126%	(Limits)
PID Surrogate Recovery:		102%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

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U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Blecha
Analyst

K Hellman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF6-MPA(S)	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4064-05	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	Matrix	: WATER
Date Received	: 11/18/96	Lab File Number(s)	: TVB21120063
Date Prepared	: 11/22/96	Method Blank	: MB2112296
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/22/96	U	0.1	mg/L
Benzene	71-43-2	11/22/96	U	0.4	ug/L
Toluene	108-88-3	11/22/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/22/96	0.9	0.4	ug/L
Ethyl Benzene	100-41-4	11/22/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/22/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/22/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/22/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/22/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/22/96	4.2	0.5	ug/L
Surrogate Recovery:		86%		70%-126%	(Limits)
Surrogate Recovery:		95%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

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U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Blecha
Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF6-MPA(D)	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4064-06	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	Matrix	: WATER
Date Received	: 11/18/96	Lab File Number(s)	: TVB21120070
Date Prepared	: 11/22/96	Method Blank	: MB2112296
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/22/96	U	0.1	mg/L
Benzene	71-43-2	11/22/96	3.0	0.4	ug/L
Toluene	108-88-3	11/22/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/22/96	32	0.4	ug/L
Ethyl Benzene	100-41-4	11/22/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/22/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/22/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/22/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/22/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/22/96	0.9	0.5	ug/L
FID Surrogate Recovery:		99%		70%-126%	([illegible])
PID Surrogate Recovery:		101%		76%-127%	([illegible])

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:
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U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
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RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Blecha
Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF06-MW19	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4064-07	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	Matrix	: WATER
Date Received	: 11/18/96	Lab File Number(s)	: TVB21120043
Date Prepared	: 11/21/96	Method Blank	: MB2112196
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/21/96	U	0.1	mg/L
Benzene	71-43-2	11/21/96	U	0.4	ug/L
Toluene	108-88-3	11/21/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/21/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/21/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/21/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/21/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/21/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/21/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/21/96	U	0.5	ug/L
FID Surrogate Recovery:		96%		70%-126%	(Limits)
PID Surrogate Recovery:		100%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Blecha
Analyst

K. Hellman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF06-MPR	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4064-08	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	Matrix	: WATER
Date Received	: 11/18/96	Lab File Number(s)	: TVB21120067
Date Prepared	: 11/22/96	Method Blank	: MB2112296
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/22/96	U	0.1	mg/L
Benzene	71-43-2	11/22/96	U	0.4	ug/L
Toluene	108-88-3	11/22/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/22/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/22/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/22/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/22/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/22/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/22/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/22/96	U	0.5	ug/L
FID Surrogate Recovery:		93%		70%-126%	(L[illegible]
PID Surrogate Recovery:		98%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Oblecha
Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	:	LF06-MPD(D)	Client Project Number	:	729691.32010
Lab Sample Number	:	96-4064-09	Lab Work Order	:	96-4064
Date Sampled	:	11/17/96	Matrix	:	WATER
Date Received	:	11/18/96	Lab File Number(s)	:	TVB21120045
Date Prepared	:	11/21/96	Method Blank	:	MB2112196
FID Dilution Factor	:	1.0			
PID Dilution Factor	:	1.0			

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/21/96	U	0.1	mg/L
Benzene	71-43-2	11/21/96	2.2	0.4	ug/L
Toluene	108-88-3	11/21/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/21/96	22	0.4	ug/L
Ethyl Benzene	100-41-4	11/21/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/21/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/21/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/21/96	0.5	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/21/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/21/96	1.7	0.5	ug/L
FID Surrogate Recovery:		92%		70%-126%	(Limits)
PID Surrogate Recovery:		98%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Bluha
Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF06-MPF(D)	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4064-10	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	Matrix	: WATER
Date Received	: 11/18/96	Lab File Number(s)	: TVB21120053
Date Prepared	: 11/21/96	Method Blank	: MB2112196
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/22/96	U	0.1	mg/L
Benzene	71-43-2	11/22/96	2.1	0.4	ug/L
Toluene	108-88-3	11/22/96	3.2	0.4	ug/L
Chlorobenzene	108-90-7	11/22/96	7.9	0.4	ug/L
Ethyl Benzene	100-41-4	11/22/96	0.5	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/22/96	1.3	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/22/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/22/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/22/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/22/96	U	0.5	ug/L
FID Surrogate Recovery:		96%		70%-126%	(Li
PID Surrogate Recovery:		97%		76%-127%	(Li

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

Analyst

Approved

Evergreen Analytical, Inc.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
TVH Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: LF6-MPN	Client Project No.	: 72691.32010
Lab Sample No.	: 96-4064-01	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	EPA Method No.	: 5030/8015 Modified
Date Received	: 11/18/96	Matrix	: WATER
Date Prepared	: 11/21/96	Lab File Number(s)	: TVB21120054,55
Date Analyzed	: 11/22/96	Method Blank	: MB2112196
Instrument Name	: TVHBTEX2	Dilution Factor	: 1.0

Compound	Spike Added (mg/L)	Sample Concentration (mg/L)	MS Concentration (mg/L)	MS %REC	QC (#) Limits %REC
Gasoline	2.00	0.00	1.60	80.1%	60 - 128
Surrogate **	---	---	---	107%	70 - 126

Compound	Spike Added (mg/L)	MSD Concentration (mg/L)	MSD %REC	RPD	QC (#) Limits	
					RPD	%REC
Gasoline	2.00	2.04	102.2%	24.3	44.1	60 - 128
Surrogate **	---	---	115%	NA	NA	70 - 126

RPD: 0 out of (1) outside limits.
Spike Recovery: 0 out of (2) outside limits.

Notes:
NA = Not analyzed/not applicable.
* = Values outside of QC limits.
** = 1,2,4-Trichlorobenzene
# = Limits established 10/1/96, MAB

Comments:

M. Blecha
Analyst

K. Hollman
Approved

MSTVHWS2;MST24064.XLS; 11/27/96

Evergreen Analytical, Inc.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

EPA 602/8020 Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: LF6-MPC(S)	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4064-02	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	EPA Method No.	: 602/8020
Date Received	: 11/18/96	Matrix	: WATER
Date Prepared	: 11/21/96	Lab File Number(s)	: TVB21120056,57
Date Analyzed	: 11/22/96	Method Blank	: MB2112196
Instrument Name	: TVHBTEX2	Dilution Factor	: 1.0

Compound	Spike Added (ug/L)	Sample Concentration (ug/L)	Concentration (ug/L) MS	Concentration (ug/L) MSD	Comments
Benzene	20.0	1.8	23.5	23.4	
Toluene	20.0	0.0	20.9	20.8	
Chlorobenzene	20.0	21.0	41.1	41.0	
Ethylbenzene	20.0	0.0	21.7	21.7	
m,p-Xylene	20.0	0.0	21.4	21.3	
o-Xylene	20.0	0.0	20.8	20.8	
1,3,5-TMB	20.0	0.0	20.1	20.0	
1,2,4-TMB	20.0	0.0	19.1	19.0	
1,2,3-TMB	20.0	0.0	21.4	21.4	
1,2,3,4-TeMB	20.0	0.0	21.3	21.2	
Surrogate	100.0	105%	101%	100%	% RECOVERY

Compound		MS % RECOVERY	MSD % RECOVERY	RPD	QC# Limits RPD	QC# Limits %REC
Benzene		108.5	108.0	0.5	17	61 - 129
Toluene		104.5	104.0	0.5	18	61 - 127
Chlorobenzene		100.5	100.0	0.5	16	68 - 122
Ethylbenzene		108.5	108.5	0.0	18	63 - 126
m,p-Xylene		107.0	106.5	0.5	18	60 - 130
o-Xylene		104.0	104.0	0.0	18	62 - 128
1,3,5-TMB		100.5	100.0	0.5	18	69 - 117
1,2,4-TMB		95.5	95.0	0.5	23	69 - 119
1,2,3-TMB		107.0	107.0	0.0	16	71 - 118
1,2,3,4-TeMB		106.5	106.0	0.5	27	67 - 125
Surrogate		101.0	100.0	NA	NA	76 - 127

= Limits established 10/15/96, KSH
* = Values outside of QC limits.

RPD: 0 out of (10) outside limits.
Spike Recovery: 0 out of (20) outside limits.

Comments:

M. Blecha
Analyst

K Hellman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
Laboratory Control Sample (LCS)

LCS Number	: LCS2112196-GAS	Matrix	: WATER
Date Prepared	: 11/21/96	Method Numbers	: EPA 5030/8015 Modified
Date Analyzed	: 11/21/96	Instrument Name	: TVHBTEX2
Lab File Number(s)	: TVB21120049		

Compound Name	Theoretical Concentration (mg/L)	LCS Concentration (mg/L)	LCS % Recovery	QC Limit % Recovery
Gasoline	2.00	2.25	112.7	81 - 128
Surrogate Recovery:		112%		70 - 126

QUALIFIERS

B = TVH as Gasoline found in blank also.
E = Extrapolated value. Value exceeds calibration range.
NA = Not Available/Not Applicable.
** = Limits established 10/1/96 for TVHBTEX2. MAB

Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 8010 Chlorinated VOC's Method Blank Report

Method Blank	:	RB112596	Client Project No.	:	729691.32010
Date Prepared	:	11/25/96	Lab Project No.	:	96-4064
Date Analyzed	:	11/25/96	Lab File No.	:	HALL1125\004F0101

Compound	CAS #	Concentration (ug/L)	RL(ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.4
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	
1,3-Dichlorobenzene	541-73-1	U	
1,2-Dichlorobenzene	95-50-1	U	

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 85% 70% - 130% (QC limits)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

PAR8010W.XLS; 12/2/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Method Blank Report

Method Blank	: RB112696	Client Project No.	: 729691.32010
Date Prepared	: 11/26/96	Lab Project No.	: 96-4064
Date Analyzed	: 11/26/96	Lab File No.	: HALL1126\005F0101

Compound	CAS #	Concentration (ug/L)	RL(ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 84% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

PAR8010W.XLS; 12/2/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF6-MPN		Client Project No.	:	729691.32010
Lab Sample No.	: 96-4064-01		Lab Project No.	:	96-4064
Date Sampled	: 11/17/96		Matrix	:	Water
Date Received	: 11/18/96		Lab File No.	:	HALL1125\009F0101
Date Prepared	: 11/25/96		Method Blank	:	RB112596
Date Analyzed	: 11/25/96		Dilution Factor	:	1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	2.4 J	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	7.2	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	23	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	11	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 100% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4064.XLS; 12/5/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF6-MPC(S)	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4064-02	Lab Project No.	: 96-4064
Date Sampled	: 11/17/96	Matrix	: Water
Date Received	: 11/18/96	Lab File No.	: HALL1125\010F0101
Date Prepared	: 11/25/96	Method Blank	: RB112596
Date Analyzed	: 11/25/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	2 J	0.4
Chloroethane	75-00-3	1.3 J	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	1.2	0.4
cis-1,2-Dichloroethene	156-59-4	0.78 J	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	14	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	0.87 J	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 95% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4064.XLS; 12/5/96

QUANT REPORT

Operator ID: KIM
Output File: ^V2960::Q1
Data File: >V2960::V2
Name: 96-4064-02 ;;;KL
Misc: 5;W;0;1;W;0;11/27/96;0

Quant Rev: 7 Quant Time: 961127 16:58
Injected at: 961127 16:33
Dilution Factor: 1.00000
Instrument ID: VOA 1

ID File: ID_824::QT
Title: ID FILE FOR APPENDIX NINE VOAs METHOD 8260A(8240)
Last Calibration: 961125 12:35 Last Qcal Date: <none>

	Compound	R.T.	Scan#	Area	Conc	Units	q
1)	*BROMOCHLOROMETHANE(INT STD)	6.14	584	35312	50.00	UG/L	82
4)	BROMOMETHANE	1.30	95	926	1.39	UG/L	100
5)	VINYL CHLORIDE	1.01	66	2722	2.06	UG/L	100
6)	CHLOROETHANE	1.37	103	1096M	2.02	UG/L	100
17)	1,1 DICHLOROETHANE	4.14	382	6910	2.49	UG/L	100
19)	CIS 1,2-DICHLOROETHENE	5.61	530	1740M	1.34	UG/L	37
23)	1,2 DICHLOROETHANE-D4(SUR STD)	7.44	715	85889	52.50	UG/L	100
24)	*1,4 DIFLUOROBENZENE(INT STD)	8.60	832	173223	50.00	UG/L	100
46)	*CHLOROBENZENE-D5(INTERNAL STD)	14.41	1418	146366	50.00	UG/L	100
53)	TOLUENE-D8(SURROGATE STD)	11.50	1124	184330	49.35	UG/L	100
55)	CHLOROBENZENE	14.46	1423	65641	21.81	UG/L	100
58)	BROMOFLUOROBENZENE(SURR STD)	17.02	1681	100170	49.13	UG/L	100
63)	1,2-DICHLOROBENZENE	20.33	2015	3486	1.43	UG/L	69
64)	1,4-DICHLOROBENZENE	19.56	1937	26122	9.79	UG/L	99

* Compound is ISTD

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF6-MPC(D)	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4064-03	Lab Project No.	: 96-4064
Date Sampled	: 11/17/96	Matrix	: Water
Date Received	: 11/18/96	Lab File No.	: HALL1125\011F0101
Date Prepared	: 11/25/96	Method Blank	: RB112596
Date Analyzed	: 11/25/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	3	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	2.3	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	2.3	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 88% 70% - 130% (QC limits)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

PAR8010W.XLS; 12/2/96

QUANT REPORT

Operator ID: KIM
Output File: ^V2961::Q1
Data File: >V2961::V2
Name: 96-4064-03 ;;;KL
Misc: 5;W;0;1;W;0;11/27/96;0

Quant Rev: 7 Quant Time: 961127 17:25
Injected at: 961127 17:00
Dilution Factor: 1.00000
Instrument ID: VOA 1

ID File: ID_824::QT
Title: ID FILE FOR APPENDIX NINE VOAs METHOD 8260A(8240)
Last Calibration: 961125 12:35 Last Qcal Date: <none>

	Compound	R.T.	Scan#	Area	Conc	Units	q
1)	*BROMOCHLOROMETHANE(INT STD)	6.12	582	29917M	50.00	UG/L	77
4)	BROMOMETHANE	1.30	95	911	1.61	UG/L	100
5)	VINYL CHLORIDE	.99	64	3691	3.30	UG/L	100
17)	1,1 DICHLOROETHANE	4.13	381	4262	1.81	UG/L	100
19)	CIS 1,2-DICHLOROETHENE	5.63	532	3194M	2.90	UG/L	76
23)	1,2 DICHLOROETHANE-D4(SUR STD)	7.45	716	72236	52.11	UG/L	100
24)	*1,4 DIFLUOROBENZENE(INT STD)	8.59	831	146335	50.00	UG/L	100
46)	*CHLOROBENZENE-D5(INTERNAL STD)	14.38	1415	124411	50.00	UG/L	100
53)	TOLUENE-D8(SURROGATE STD)	11.45	1119	155753	49.06	UG/L	100
55)	CHLOROBENZENE	14.43	1420	13653	5.34	UG/L	100
58)	BROMOFLUOROBENZENE(SURR STD)	17.01	1680	84559	48.80	UG/L	100
64)	1,4-DICHLOROBENZENE	19.57	1939	19287	8.51	UG/L	96

* Compound is ISTD

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF6-MPJ	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4064-04	Lab Project No.	: 96-4064
Date Sampled	: 11/17/96	Matrix	: Water
Date Received	: 11/18/96	Lab File No.	: HALL1125\012F0101
Date Prepared	: 11/25/96	Method Blank	: RB112596
Date Analyzed	: 11/25/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	2.1 J	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
[illegible]-Chlorotoluene	106-49-8	U	0.4
[illegible]3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 86% 70% - 130% (QC limits)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4064.XLS; 12/5/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF6-MPA(S)	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4064-05	Lab Project No.	: 96-4064
Date Sampled	: 11/17/96	Matrix	: Water
Date Received	: 11/18/96	Lab File No.	: HALL1125\013F0101
Date Prepared	: 11/25/96	Method Blank	: RB112596
Date Analyzed	: 11/25/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 83% 70% - 130% (QC limits)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

PAR8010W.XLS; 12/2/96

QUANT REPORT Page 1

Operator ID: KIM Quant Rev: 7 Quant Time: 961127 18:24
Output File: ^V2963::Q1 Injected at: 961127 17:54
Data File: >V2963::V2 Dilution Factor: 1.00000
Name: 96-4064-05 ;;;KL Instrument ID: VOA 1
Misc: 5;W;0;1;W;0;11/27/96;0

ID File: ID_824::Q7
Title: ID FILE FOR APPENDIX NINE VOAs METHOD 8260A(8240)
Last Calibration: 961125 12:35 Last Qcal Time: <none>

	Compound	R.T.	Scan#	Area	Conc	Units	q
1)	*BROMOCHLOROMETHANE(INT STD)	6.10	580	34600	50.00	UG/L	80
23)	1,2 DICHLOROETHANE-D4(SUR STD)	7.41	712	85398	53.27	UG/L	100
24)	*1,4 DIFLUOROBENZENE(INT STD)	8.57	829	166354	50.00	UG/L	100
46)	*CHLOROBENZENE-D5(INTERNAL STD)	14.42	1419	140659	50.00	UG/L	100
53)	TOLUENE-D8(SURROGATE STD)	11.47	1121	181121	50.46	UG/L	100
55)	CHLOROBENZENE	14.49	1426	2791	.965	UG/L	100
58)	BROMOFLUOROBENZENE(SURR STD)	17.05	1684	96503	49.26	UG/L	100
63)	1,2-DICHLOROBENZENE	20.37	2019	953	.408	UG/L	94
64)	1,4-DICHLOROBENZENE	19.60	1942	7957	3.10	UG/L	94

* Compound is ISTD

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF6-MPA(D)	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4064-06	Lab Project No.	: 96-4064
Date Sampled	: 11/17/96	Matrix	: Water
Date Received	: 11/18/96	Lab File No.	: HALL1125\014F0101
Date Prepared	: 11/25/96	Method Blank	: RB112596
Date Analyzed	: 11/25/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	6.6	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	1.2	0.4
cis-1,2-Dichloroethene	156-59-4	0.44 J X	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	20	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	0.88 J	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 93% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES: X =Not confirmed by MS (MDL 1ug/L).

Analyst

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QUANT REPORT Page 1

Operator ID: KIM Quant Rev: 7 Quant Time: 961127 18:52
Output File: ^V2964::Q1 Injected at: 961127 18:28
Data File: >V2964::V2 Dilution Factor: 1.00000
Name: 96-4064-06 ;;;KL Instrument ID: VOA 1
Misc: 5;W;0;1;W;0;11/27/96;0

ID File: ID_824::QT
Title: ID FILE FOR APPENDIX NINE VOAs METHOD 8260A(8240)
Last Calibration: 961125 12:35 Last Qcal Time: <none>

	Compound	R.T.	Scan#	Area	Conc	Units	q
1)	*BROMOCHLOROMETHANE(INT STD)	6.14	584	35279	50.00	UG/L	82
4)	BROMOMETHANE	1.31	96	860	1.29	UG/L	100
5)	VINYL CHLORIDE	.98	63	11930M	9.06	UG/L	100
11)	METHYLENE CHLORIDE	2.90	257	913	.759	UG/L	37
17)	1,1 DICHLOROETHANE	4.15	383	6842	2.47	UG/L	100
23)	1,2 DICHLOROETHANE-D4(SUR STD)	7.48	719	87257	53.38	UG/L	100
24)	*1,4 DIFLUOROBENZENE(INT STD)	8.62	834	176110	50.00	UG/L	100
46)	*CHLOROBENZENE-D5(INTERNAL STD)	14.43	1420	145633	50.00	UG/L	100
53)	TOLUENE-D8(SURROGATE STD)	11.50	1124	185761	49.98	UG/L	100
55)	CHLOROBENZENE	14.47	1424	94670	31.61	UG/L	100
58)	BROMOFLUOROBENZENE(SURR STD)	17.06	1685	96035	47.34	UG/L	100
63)	1,2-DICHLOROBENZENE	20.37	2019	2266	.937	UG/L	77
64)	1,4-DICHLOROBENZENE	19.61	1942	49536	18.67	UG/L	96

* Compound is ISTD

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF06-MW19	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4064-07	Lab Project No.	: 96-4064
Date Sampled	: 11/17/96	Matrix	: Water
Date Received	: 11/18/96	Lab File No.	: HALL1125\018F0101
Date Prepared	: 11/25/96	Method Blank	: RB112596
Date Analyzed	: 11/25/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	[illegible]
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 88% 70% - 130% (QC limits)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

PAR8010W.XLS; 12/2/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF06-MPR	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4064-08	Lab Project No.	: 96-4064
Date Sampled	: 11/17/96	Matrix	: Water
Date Received	: 11/18/96	Lab File No.	: HALL1126\006F0101
Date Prepared	: 11/26/96	Method Blank	: RB112696
Date Analyzed	: 11/26/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 89% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

PAR8010W.XLS; 12/2/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	:	LF06-MPD(D)	Client Project No.	:	729691.32010
Lab Sample No.	:	96-4064-09	Lab Project No.	:	96-4064
Date Sampled	:	11/17/96	Matrix	:	Water
Date Received	:	11/18/96	Lab File No.	:	HALL1125\020F0101
Date Prepared	:	11/25/96	Method Blank	:	RB112596
Date Analyzed	:	11/25/96	Dilution Factor	:	1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	4.2	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	13	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	[illegible]
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	0.8 J	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 87% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

QUANT REPORT

Operator ID: KIM
Output File: ^V2965::Q1
Data File: >V2965::V2
Name: 96-4064-09 ;;;KL
Misc: 5;W;0;1;W;0;11/27/96;0

Quant Rev: 7 Quant Time: 961127 19:19
Injected at: 961127 18:55
Dilution Factor: 1.00000
Instrument ID: VOA 1

ID File: ID_824::Q1
Title: ID FILE FOR APPENDIX NINE VOAs METHOD 8260A(8240)
Last Calibration: 961125 12:35 Last Qcal Time: <none>

	Compound	R.T.	Scan#	Area	Conc	Units	q
1)	*BROMOCHLOROMETHANE(INT STD)	6.14	584	33734	50.00	UG/L	81
4)	BROMOMETHANE	1.30	95	771M	1.21	UG/L	100
5)	VINYL CHLORIDE	.99	64	8873	7.04	UG/L	100
17)	1,1 DICHLOROETHANE	4.18	386	3602	1.36	UG/L	100
23)	1,2 DICHLOROETHANE-D4(SUR STD)	7.45	716	79881	51.11	UG/L	100
24)	*1,4 DIFLUOROBENZENE(INT STD)	8.60	832	165416	50.00	UG/L	100
46)	*CHLOROBENZENE-D5(INTERNAL STD)	14.41	1418	134110	50.00	UG/L	100
53)	TOLUENE-D8(SURROGATE STD)	11.50	1124	165947	48.49	UG/L	100
55)	CHLOROBENZENE	14.47	1424	63962	23.19	UG/L	100
58)	BROMOFLUOROBENZENE(SURR STD)	17.03	1682	86455	46.28	UG/L	100
63)	1,2-DICHLOROBENZENE	20.36	2018	2054	.922	UG/L	84
64)	1,4-DICHLOROBENZENE	19.59	1940	69048	28.26	UG/L	98

* Compound is ISTD

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	:	LF06-MPF(D)	Client Project No.	:	729691.32010
Lab Sample No.	:	96-4064-10	Lab Project No.	:	96-4064
Date Sampled	:	11/17/96	Matrix	:	Water
Date Received	:	11/18/96	Lab File No.	:	HALL1125\021F0101
Date Prepared	:	11/25/96	Method Blank	:	RB112596
Date Analyzed	:	11/25/96	Dilution Factor	:	1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	1.7 J	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	6.1	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 81% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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HLW4064.XLS; 12/5/96

QUANT REPORT

Operator ID: KIM
Quant Rev: 7
Quant Time: 961127 19:46
Output File: ^V2966::Q1
Injected at: 961127 19:22
Data File: >V2966::V2
Dilution Factor: 1.00000
Name: 96-4064-10 ;;;KL
Instrument ID: VOA 1
Misc: 5;W;0;1;W;0;11/27/96;0

ID File: ID_824::QT
Title: ID FILE FOR APPENDIX NINE VOAs METHOD 8260A(8240)
Last Calibration: 961125 12:35
Last Qcal Date: <none>

	Compound	R.T.	Scan#	Area	Conc	Units	q
1)	*BROMOCHLOROMETHANE(INT STD)	6.14	584	34237	50.00	UG/L	79
4)	BROMOMETHANE	1.31	96	810	1.25	UG/L	100
5)	VINYL CHLORIDE	.99	64	1849	1.45	UG/L	100
23)	1,2 DICHLOROETHANE-D4(SUR STD)	7.46	717	80532	50.77	UG/L	100
24)	*1,4 DIFLUOROBENZENE(INT STD)	8.61	833	168480	50.00	UG/L	100
46)	*CHLOROBENZENE-D5(INTERNAL STD)	14.41	1418	138860	50.00	UG/L	100
53)	TOLUENE-D8(SURROGATE STD)	11.48	1122	172848	48.78	UG/L	100
55)	CHLOROBENZENE	14.47	1424	35637	12.48	UG/L	100
58)	BROMOFLUOROBENZENE(SURR STD)	17.04	1683	89320	46.18	UG/L	100
64)	1,4-DICHLOROBENZENE	19.58	1939	25976	10.27	UG/L	94

* Compound is ISTD

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(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: Trip Blank #7	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4064-11	Lab Project No.	: 96-4064
Date Sampled	: 11/17/96	Matrix	: Water
Date Received	: 11/18/96	Lab File No.	: HALL1125\022F0101
Date Prepared	: 11/25/96	Method Blank	: RB112596
Date Analyzed	: 11/25/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.4
1,1,2,2-Tetrachloroethane	79-34-5	U	0.42
2-Chlorotoluene	95-49-8	U	0.54
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 83% 70% - 130% (QC limits)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

Method 8010 Quality Control Samples

Date Performed: 11/25/96

Reference Standard: V832

Analyte	M	Method Blank	Sample 96-4064-06	Sample Spike	Spike Dup.	Control Spike	Spike Amt	RPD	Spike Recoveries Sample	Dup	#	Control	#	QC Recovery Range %L - %H	Low - High
Vinyl Chloride	w		6.641	23.331	25.293	16.886	20.0	11.1	83%	93%		84%		28 - 163	5.60 - 32.60
Chloroethane	*			18.504	19.768	19.268	20.0	6.6	93%	99%		96%		46 - 137	9.20 - 27.40
1,1-Dichloroethene	*			18.334	18.644	19.713	20.0	1.7	92%	93%		99%		28 - 167	5.60 - 33.40
Dichloromethane	*		0.105	16.867	18.358	18.624	20.0	8.5	84%	91%		93%		25 - 162	5.00 - 32.40
trans-1,2-Dichloroethene	*			21.68	22.698	23.188	20.0	4.6	108%	113%		116%		38 - 155	7.60 - 31.00
1,1-Dichloroethane	*		1.168	21.339	22.832	21.399	20.0	7.1	101%	108%		107%		47 - 132	9.40 - 26.40
cis-1,2-Dichloroethene	*		0.438	21.454	22.411	21.414	20.0	4.5	105%	110%		107%		-	-
1,1,1-Trichloroethane	*			20.253	20.633	21.329	20.0	1.9	101%	103%		107%		41 - 138	8.20 - 27.60
Carbon Tetrachloride	*			20.29	21.154	21.504	20.0	4.2	101%	106%		108%		43 - 143	8.60 - 28.60
Trichloroethene	w			23.016	21.14	22.011	20.0	8.5	115%	106%		110%		35 - 146	7.00 - 29.20
1,1,2-Trichloroethane	w			20.375	20.758	22.008	20.0	1.9	102%	104%		110%		39 - 136	7.80 - 27.20
Tetrachloroethene	*		0.115	22.404	21.707	21.617	20.0	3.2	111%	108%		108%		26 - 162	5.20 - 32.40
1,1,1,2-Tetrachloroethane	*			19.447	18.92	19.287	20.0	2.7	97%	95%		96%		-	-
Chlorobenzene	*		20.161	43.358	46.282	21.459	20.0	11.9	116%	131%		107%		1 - 150	0.16 - 30.00
1,1,2,2-Tetrachloroethane	*			18.977	19.794	22.404	20.0	4.2	95%	99%		112%		8 - 184	1.60 - 36.80
2-Chlorotoluene	*			17.9	19.701	19.169	20.0	9.6	90%	99%		96%		-	-
4-Chlorotoluene	*			17.787	18.487	19.732	20.0	3.9	89%	92%		99%		-	-
1,3-Dichlorobenzene	*			17.124	18.499	18.886	20.0	7.7	86%	92%		94%		7 - 187	1.40 - 37.40
1,2-Dichlorobenzene	*		0.875	17.34	17.97	17.990	20.0	3.8	82%	85%		90%		0 - 208	0.00 - 41.60

M = Applicable matrices. (* = Soil and Water. w = Water only.)

= Marks a spike recovery out of limits.
If recovery is outside method limit, marked with "*".
If recovery is outside a guideline, marked with "~".
If the sample spike recovery is outside the limit and the control spike is outside the limit also, the control is marked with "**" or "~~".

Notes on recovery limits:

All spiked analytes must be detected even if low limit is 0.
For analytes not listed in the method, recovery limits of 50-150% will be used as guidelines until limits can be established.

Corrective Actions:

Unacceptable sample spike recovery requires acceptable control spike recovery. If both recoveries are outside limits, corrective action must be taken. One recovery outside limits and the other acceptable, is a warning. Repeated failure requires corrective action. Recoveries outside guidelines should be compared to historical data available to determine if corrective action is required.

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(303) 425-6021

Methane Report Form
Method Blank Report

Method Blank Number	: GB112696	Client Project No.	: 729691.32010
Date Extracted/Prepared	: 11/26/96	Lab Work Order	: 96-4064
Date Analyzed	: 11/26/96	Dilution Factor	: 1.00
		Method	: RSKSOP-175M
		Matrix	: Water
		Lab File No.	: GAS1126002

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K Hollman
Approved

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(303) 425-6021

Methane Report Form

Client Sample Number	:	LF6-MPN	Client Project No.	:	729691.32010
Lab Sample Number	:	96-4064-01	Lab Work Order	:	96-4064
Date Sampled	:	11/17/96	Dilution Factor	:	1.00
Date Received	:	11/18/96	Method	:	RSKSOP-175M
Date Extracted/Prepared	:	11/26/96	Matrix	:	Water
Date Analyzed	:	11/26/96	Lab File No.	:	GAS1126008

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.059	0.002

Temperature	:	70.6 F	Saturation Concentration	Meth	0.014083379
Amount Injected	:	0.5 ml			
Total Volume of Sample	:	43 ml	Concentration in Head Space	Meth	0.044490838
Head space created	:	4 ml			
Methane Area	:	327.502 ug			

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Hollman
Approved

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(303) 425-6021

Methane Report Form

Client Sample Number	: LF6-MPC(S)	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4064-02	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	Dilution Factor	: 50.00
Date Received	: 11/18/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/26/96	Matrix	: Water
Date Analyzed	: 11/26/96	Lab File No.	: GAS1126009

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	1.9	0.1

Temperature	:	70.7 F
Amount Injected	:	0.01 ml
Total Volume of Sample	:	43 ml
Head space created	:	4 ml
Methane Area	:	210.009 ug

Saturation Concentration	Meth	0.4515[illegible]
Concentration in Head Space	Meth	1.42620713

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Hellman
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Methane Report Form

Client Sample Number	: LF6-MPC(D)	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4064-03	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	Dilution Factor	: 10.00
Date Received	: 11/18/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/26/96	Matrix	: Water
Date Analyzed	: 11/26/96	Lab File No.	: GAS1126010

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.35	0.02

erature	:	71	F
nt Injected	:	0.05	ml
Total Volume of Sample	:	43	ml
Head space created	:	4	ml
Methane Area	:	194.076	ug
Atomic weight(Methane)	:	16	g

Saturation Concentration	Meth	0.083457379
Concentration in Head Space	Meth	0.263451584

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Hollman
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(303) 425-6021

Methane Report Form

Client Sample Number	: LF6-MPJ	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4064-04	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	Dilution Factor	: 1.00
Date Received	: 11/18/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/26/96	Matrix	: Water
Date Analyzed	: 11/26/96	Lab File No.	: GAS1126011

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.017	0.002

Temperature	: 70.4 F	Saturation Concentration	Meth	0.004[illegible]1
Amount Injected	: 0.5 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.012[illegible]85
Head space created	: 4 ml			
Methane Area	: 93.023 ug			

Atomic weight(Methane) : 16 g

Qualifiers

E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA =Not Available/Not Applicable.

Analyst

K Hollman
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Methane Report Form

Client Sample Number	: LF6-MPA(S)	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4064-05	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	Dilution Factor	: 10.00
Date Received	: 11/18/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/26/96	Matrix	: Water
Date Analyzed	: 11/26/96	Lab File No.	: GAS1126012

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.85	0.02

erature	:	70.5 F	Saturation	Meth	0.204831283
A t Injected	:	0.05 ml	Concentration		
Total Volume of Sample	:	43 ml	Concentration	Meth	0.647205133
Head space created	:	4 ml	in Head Space		
Methane Area	:	476.325 ug			

Atomic weight(Methane)	:	16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
'A = Not Available/Not Applicable.

Analyst

K. Hollman
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(303) 425-6021

Methane Report Form

Client Sample Number	: LF6-MPA(D)	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4064-06	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	Dilution Factor	: 10.00
Date Received	: 11/18/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/26/96	Matrix	: Water
Date Analyzed	: 11/26/96	Lab File No.	: GAS1126013

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.31	0.02

Temperature	: 70.8 F	Saturation Concentration	Meth	0.074[illegible]
Amount Injected	: 0.05 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.235[illegible]61
Head space created	: 4 ml			
Methane Area	: 173.395 ug			

Atomic weight(Methane) : 16 g

Qualifiers

E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

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Methane Report Form

Client Sample Number	: LF06-MW19	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4064-07	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	Dilution Factor	: 1.00
Date Received	: 11/18/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/26/96	Matrix	: Water
Date Analyzed	: 11/26/96	Lab File No.	: GAS1126014

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Temperature	:	70.3 F
Amount Injected	:	0.5 ml
Total Volume of Sample	:	43 ml
Head space created	:	4 ml
Methane Area	:	0 ug
Atomic weight(Methane)	:	16 g

Saturation Concentration	Meth	0
Concentration in Head Space	Meth	0

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Holloman
Approved

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: LF06-MPR	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4064-08	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	Dilution Factor	: 1.00
Date Received	: 11/18/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/26/96	Matrix	: Water
Date Analyzed	: 11/26/96	Lab File No.	: GAS1126016

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.012	0.002

Temperature	:	70.6 F
Amount Injected	:	0.5 ml
Total Volume of Sample	:	43 ml
Head space created	:	4 ml
Methane Area	:	68.943 ug
Atomic weight(Methane)	:	16 g

Saturation Concentration	Meth	0.002
Concentration in Head Space	Meth	0.0093658

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Hollman
Approved

AF4064.XLS

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4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: LF06-MPR	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4064-08Dup	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	Dilution Factor	: 1.00
Date Received	: 11/18/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/26/96	Matrix	: Water
Date Analyzed	: 11/26/96	Lab File No.	: GAS1126017

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.012	0.002

erature	:	70.7 F	Saturation Concentration	Meth	0.002767593
nt Injected	:	0.5 ml			
Total Volume of Sample	:	43 ml	Concentration in Head Space	Meth	0.00874146
Head space created	:	4 ml			
Methane Area	:	64.359 ug			
Atomic weight(Methane)	:	16 g			

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA =Not Available/Not Applicable.

Bill Michener
Analyst

K Hellman
Approved

AF4064.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: LF06-MPD(D)	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4064-09	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	Dilution Factor	: 10.00
Date Received	: 11/18/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/26/96	Matrix	: Water
Date Analyzed	: 11/26/96	Lab File No.	: GAS1126018

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.24	0.02

Temperature	:	70.6 F
Amount Injected	:	0.05 ml
Total Volume of Sample	:	43 ml
Head space created	:	4 ml
Methane Area	:	132.894 ug

Saturation Concentration	Meth	0.0571[illegible]
Concentration in Head Space	Meth	0.1805[illegible]24

Atomic weight(Methane) : 16 g

Qualifiers

E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

[illegible]
Analyst

K. Hollman
Approved

AF4064.XLS

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4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: LF06-MPF(D)	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4064-10	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	Dilution Factor	: 10.00
Date Received	: 11/18/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/26/96	Matrix	: Water
Date Analyzed	: 11/26/96	Lab File No.	: GAS1126019

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.44	0.02

erature	: 70.9 F	Saturation Concentration Meth	0.104705306
nt Injected	: 0.05 ml		
Total Volume of Sample	: 43 ml	Concentration in Head Space Meth	0.330587667
Head space created	: 4 ml		
Methane Area	: 243.487 ug		

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Holman
Approved

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Evergreen Analytical, Inc.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

RSKSOP-175M Gas Method
Methane Gas Matrix Spike / Matrix Spike Duplicate Report

Client Sample No.	: LF6-MPJ	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4064-04	Lab Work Order	: 96-4064
Date Sampled	: 11/17/96	EPA Method No.	: RSKSOP-175M
Date Received	: 11/18/96	Matrix	: Water
Date Prepared	: 11/26/96	Method Blank	: GB112696
Date Analyzed	: 11/26/96	Lab File No's.	: GAS1126020,021
E.A. MS/MSD Spike Source No.	: 1886		

Compound	Spike Added (ug)	Sample Concentration (ug)	MS Concentration (ug)	MS %REC	QC Limits %REC
Methane Gas	500	93	429	67	47-88

Compound	Spike Added (ug)	MSD Concentration (ug)	MSD %REC	RPD	QC Limits RPD	QC Limits %REC
Methane Gas	500	427	67	0.5	0-16.4	47-88

RPD: 0 out of (1) outside limits.
Spike Recovery: 0 out of (2) outside limits.

Notes
* = Values outside of QC limits.
NA = Not analyzed/not available

Note: The Spike was made by taking the sample and displacing 4ml of headspace with a 1% methane gas and shaking the VOA for 5 minutes. Then injecting 50 ul from the headspace into the GC resulting in a theoretical concentration of 500 ug.

Analyst

K. Hollman
Approved

MS4064.XLS; 11/26/96

Evergreen Analytical, Inc.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

RSKSOP-175M Gas Method
Methane LCS Report Form

LCS No.	: LCS112696	EPA Method No.	: RSKSOP-175M
Date Prepared	: 11/26/96	Matrix	: Water
Date Analyzed	: 11/26/96	Method Blank	: GB112696
E.A. LCS Source No.	: 1886	Lab File No.	: GAS1126006

Compound	Spike Added (ug)	Method Blank Concentration (ug)	LCS Concentration (ug)	LCS %REC	QC Limits %REC
Methane Gas	500	0	436	87	64-90

Spike Recovery: 0 out of (1) outside limits.

Note: The LCS was made by taking the sample and displacing 4ml of headspace with a 1% methane gas and shaking the VOA for 5 minutes. Then injecting 50 ul from the headspace into the GC resulting in a theoretical concentration of 500 ug.

Notes
* = Values outside of QC limits.
NA = Not analyzed/not available.

Analyst

K. Hellman
Approved

LCS1126.XLS; 11/26/96

EVERGREEN ANALYTICAL, Inc.
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(303) 425-6021

Anion Report

Date Sampled	: 11/17/96		Client Project ID.	:	729691.32010
Date Received	: 11/18/96		Lab Project Number	:	96-4064
Date Prepared	: 11/18/96		Method	:	EPA 300.0
Date Analyzed	: 11/18/96		Detection Limit	:	0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Chloride (mg/L)	Dilution Factor
96-4064-01	LF6-MPN	Water	23.1	10
96-4064-02	LF6-MPC(S)	Water	13.2	1
96-4064-03	LF6-MPC(D)	Water	36.6	10
96-4064-04	LF6-MPJ	Water	23.4	1
96-4064-05	LF6-MPA(S)	Water	4.2	1
96-4064-06	LF6-MPA(D)	Water	18.4	1
96-4064-07	LF06-MW19	Water	2.3	1
96-4064-08	LF06-MPR	Water	271	10
96-4064-09	LF06-MPD(D)	Water	7.2	1
96-4064-10	LF06-MPF(D)	Water	22.4	1
Method Blank	(11/18/96)	Water	<0.25	1

Quality Assurance*

Reference	True Value (mg/L)	Result (mg/L)	% Recovery
Alltech Anion Mixtue A Lot # 728550	20.0	19.6	98

* = Laboratory control sample results reported for quality assurance due to spike values exceeding calibration range. No duplicate of diluted sample analyzed.

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/17/96	Client Project ID.	: 729691.32010
Date Received	: 11/18/96	Lab Project Number	: 96-4064
Date Prepared	: 11/18/96	Method	: EPA 300.0
Date Analyzed	: 11/18/96	Detection Limit	: 0.076 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrite-N (mg/L)	Dilution Factor
96-4064-01	LF6-MPN	Water	<0.076	1
96-4064-01 Duplicate	LF6-MPN Duplicate	Water	<0.076	1
96-4064-02	LF6-MPC(S)	Water	<0.076	1
96-4064-03	LF6-MPC(D)	Water	<0.076	1
96-4064-04	LF6-MPJ	Water	<0.076	1
96-4064-05	LF6-MPA(S)	Water	<0.076	1
96-4064-06	LF6-MPA(D)	Water	<0.076	1
96-4064-07	LF06-MW19	Water	<0.076	1
96-4064-08	LF06-MPR	Water	<0.76**	10
96-4064-09	LF06-MPD(D)	Water	<0.076	1
96-4064-10	LF06-MPF(D)	Water	<0.076	1
Method Blank	(11/18/96)	Water	<0.076	1

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4064-01	LF6-MPN Matrix Spike	10.0	<0.25	9.6	96
96-4064-01	LF6-MPN Matrix Spike Dup	10.0	<0.25	9.2	92
MS/MSD RPD					4.0

* = Quality assurance results reported as Nitrite (NO_2).
** = Raised detection limit due to matrix interference.

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
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Anion Report

Date Sampled	:	11/17/96	Client Project ID.	:	729691.32010
Date Received	:	11/18/96	Lab Project Number	:	96-4064
Date Prepared	:	11/18/96	Method	:	EPA 300.0
Date Analyzed	:	11/18/96	Detection Limit	:	0.056 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrate-N (mg/L)	Dilution Factor
96-4064-01	LF6-MPN	Water	<0.056	1
96-4064-01 Duplicate	LF6-MPN Duplicate	Water	<0.056	1
96-4064-02	LF6-MPC(S)	Water	<0.056	1
96-4064-03	LF6-MPC(D)	Water	0.39	1
96-4064-04	LF6-MPJ	Water	<0.056	1
96-4064-05	LF6-MPA(S)	Water	<0.056	1
96-4064-06	LF6-MPA(D)	Water	<0.056	1
96-4064-07	LF06-MW19	Water	0.81	1
96-4064-08	LF06-MPR	Water	0.30	1
96-4064-09	LF06-MPD(D)	Water	<0.056	1
96-4064-10	LF06-MPF(D)	Water	<0.056	1
Method Blank	(11/18/96)	Water	<0.056	1

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4064-01	LF6-MPN Matrix Spike	10.0	<0.25	9.3	93
96-4064-01	LF6-MPN Matrix Spike Dup	10.0	<0.25	9.1	91
MS/MSD RPD					2.0

* = Quality assurance results reported as Nitrate (NO_3).

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
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Anion Report

Date Sampled : 11/17/96
Date Received : 11/18/96
Date Prepared : 11/18/96
Date Analyzed : 11/18/96

Client Project ID. : 729691.32010
Lab Project Number : 96-4064
Method : EPA 300.0
Detection Limit : 0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Sulfate (mg/L)	Dilution Factor
96-4064-01	LF6-MPN	Water	2.3	1
96-4064-01 Duplicate	LF6-MPN Duplicate	Water	2.2	1
96-4064-02	LF6-MPC(S)	Water	4.0	1
96-4064-03	LF6-MPC(D)	Water	<0.25	1
96-4064-04	LF6-MPJ	Water	0.36	1
96-4064-05	LF6-MPA(S)	Water	119	10
96-4064-06	LF6-MPA(D)	Water	1.3	1
96-4064-07	LF06-MW19	Water	11.0	1
96-4064-08	LF06-MPR	Water	0.88	1
96-4064-09	LF06-MPD(D)	Water	4.8	1
96-4064-10	LF06-MPF(D)	Water	1.0	1
Method Blank	(11/18/96)	Water	<0.25	1

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4064-01	LF6-MPN Matrix Spike	10.0	2.3	11.5	93
96-4064-01	LF6-MPN Matrix Spike Dup	10.0	2.3	11.2	90
MS/MSD RPD					3.2

Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF06-MPG	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4081-02	Lab Work Order	: 96-4081
Date Sampled	: 11/18/96	Matrix	: WATER
Date Received	: 11/19/96	Lab File Number(s)	: TVB21120008
Date Prepared	: 11/20/96	Method Blank	: MB2112096
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/20/96	U	0.1	mg/L
Benzene	71-43-2	11/20/96	U	0.4	ug/L
Toluene	108-88-3	11/20/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/20/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/20/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/20/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/20/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/20/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/20/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/20/96	U	0.5	ug/L
Surrogate Recovery:		96%		70%-126%	(Limits)
Surrogate Recovery:		99%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Blecha
Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: W3	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4081-04	Lab Work Order	: 96-4081
Date Sampled	: 11/18/96	Matrix	: WATER
Date Received	: 11/19/96	Lab File Number(s)	: TVB21120010
Date Prepared	: 11/20/96	Method Blank	: MB2112096
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/20/96	0.3	0.1	mg/L
Benzene	71-43-2	11/20/96	15	0.4	ug/L
Toluene	108-88-3	11/20/96	1.2	0.4	ug/L
Chlorobenzene	108-90-7	11/20/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/20/96	2.7	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/20/96	3.5	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/20/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/20/96	0.4	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/20/96	8.4	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/20/96	27	0.5	ug/L
FID Surrogate Recovery:		123%		70%-126%	(Lin
PID Surrogate Recovery:		121%		76%-127%	(Lin

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Blecha
Analyst

K. Hellman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF06-MPF(S)	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4081-05	Lab Work Order	: 96-4081
Date Sampled	: 11/18/96	Matrix	: WATER
Date Received	: 11/19/96	Lab File Number(s)	: TVB21120011*
Date Prepared	: 11/20,25/96	Method Blanks	: MB2112096*
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0; 20		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/20/96	0.6	0.1	mg/L
Benzene	71-43-2	11/20/96	12	0.4	ug/L
Toluene	108-88-3	11/20/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/25/96	300	8.0	ug/L
Ethyl Benzene	100-41-4	11/20/96	22	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/20/96	14	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/20/96	3.4	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/20/96	9.9	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/20/96	5.1	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/20/96	5.7	0.5	ug/L
FID Surrogate Recovery:		112%		70%-126%	(Limits)
PID Surrogate Recovery:		114%; 91%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments: *TVB21125010 and MB2112596

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Blacha
Analyst

K Holleman
Approved

EVERGREEN ANALYTICAL, INC.
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Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF06-MPV	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4081-06	Lab Work Order	: 96-4081
Date Sampled	: 11/18/96	Matrix	: WATER
Date Received	: 11/19/96	Lab File Number(s)	: TVB21120029,59
Date Prepared	: 11/21,22/96	Method Blanks	: MB2112196
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0; 20		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/21/96	0.6	0.1	mg/L
Benzene	71-43-2	11/21/96	12	0.4	ug/L
Toluene	108-88-3	11/21/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/22/96	280	8.0	ug/L
Ethyl Benzene	100-41-4	11/21/96	21	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/21/96	14	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/21/96	3.5	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/21/96	10	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/21/96	4.9	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/21/96	5.0	0.5	ug/L
FID Surrogate Recovery:		106%		70%-126%	
PID Surrogate Recovery:		105%;96%		76%-127%	

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

M. Blecha
Analyst

AMcClellan
Approved

EVERGREEN ANALYTICAL, INC.
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Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: LF06-MPB	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4081-08	Lab Work Order	: 96-4081
Date Sampled	: 11/18/96	Matrix	: WATER
Date Received	: 11/19/96	Lab File Number(s)	: TVB21120013
Date Prepared	: 11/20/96	Method Blank	: MB2112096
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/20/96	U	0.1	mg/L
Benzene	71-43-2	11/20/96	U	0.4	ug/L
Toluene	108-88-3	11/20/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/20/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/20/96.	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/20/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/20/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/20/96	0.9	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/20/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/20/96	0.6	0.5	ug/L
Surrogate Recovery:		111%		70%-126%	(Limits)
Surrogate Recovery:		104%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

Analyst

Approved

Evergreen Analytical, Inc.
4036 Youngfield, Wheat Ridge, CO 80033
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TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
TVH Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: W3	Client Project No.	: 72691.32010
Lab Sample No.	: 96-4081-04	Lab Work Order	: 96-4081
Date Sampled	: 11/18/96	EPA Method No.	: 5030/8015 Modified
Date Received	: 11/19/96	Matrix	: WATER
Date Prepared	: 11/20/96	Lab File Number(s)	: TVB21120023,24
Date Analyzed	: 11/21/96	Method Blank	: MB2112096
Instrument Name	: TVHBTEX2	Dilution Factor	: 1.0

Compound	Spike Added (mg/L)	Sample Concentration (mg/L)	MS Concentration (mg/L)	MS %REC	QC (#) Limits %REC
Gasoline	2.00	0.34	2.49	107.7%	60 - 128
Surrogate **	---	---	---	136% *	70 - 126

Compound	Spike Added (mg/L)	MSD Concentration (mg/L)	MSD %REC	RPD	QC (#) Limits RPD	QC (#) Limits %REC
Gasoline	2.00	2.49	107.5%	0.1	44.1	60 - 128
Surrogate **	---	---	133% *	NA	NA	70 - 126

RPD: 0 out of (1) outside limits.
Spike Recovery: 0 out of (2) outside limits.

Notes:
NA = Not analyzed/not applicable.
* = Values outside of QC limits.
** = 1,2,4-Trichlorobenzene
# = Limits established 10/1/96, MAB

Comments: * = High Surrogate Recovery due to hydrocarbon interference.

Analyst

K. Hollman
Approved

MSTVHWS2;MST24081.XLS; 11/25/96

Evergreen Analytical, Inc.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

EPA 602/8020 Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: LF06-MPG	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4081-02	Lab Work Order	: 96-4081
Date Sampled	: 11/18/96	EPA Method No.	: 602/8020
Date Received	: 11/19/96	Matrix	: WATER
Date Prepared	: 11/20/96	Lab File Number(s)	: TVB21120021,22
Date Analyzed	: 11/20/96	Method Blank	: MB2112096
Instrument Name	: TVHBTEX2	Dilution Factor	: 1.0

Compound	Spike Added (ug/L)	Sample Concentration (ug/L)	Concentration (ug/L)		Comments
			MS	MSD	
Benzene	20.0	0.0	21.9	22.1	
Toluene	20.0	0.0	21.2	21.6	
Chlorobenzene	20.0	0.0	21.0	21.3	
Ethylbenzene	20.0	0.0	21.1	21.5	
m,p-Xylene	20.0	0.0	21.1	21.5	
o-Xylene	20.0	0.0	21.0	21.3	
1,3,5-TMB	20.0	0.0	20.7	21.0	
1,2,4-TMB	20.0	0.0	20.4	20.8	
1,2,3-TMB	20.0	0.0	21.0	21.3	
1,2,3,4-TeMB	20.0	0.0	21.2	21.3	
Surrogate	100.0	99%	106%	103%	% RECOVERY

Compound		MS % RECOVERY	MSD % RECOVERY	RPD	QC# Limits		
					RPD	%REC	
Benzene		109.5	110.5	0.9	17	61	129
Toluene		106.0	108.0	1.9	18	61	127
Chlorobenzene		105.0	106.5	1.4	16	68	122
Ethylbenzene		105.5	107.5	1.9	18	63	126
m,p-Xylene		105.5	107.5	1.9	18	60	130
o-Xylene		105.0	106.5	1.4	18	62	128
1,3,5-TMB		103.5	105.0	1.4	18	69	117
1,2,4-TMB		102.0	104.0	1.9	23	69	119
1,2,3-TMB		105.0	106.5	1.4	16	71	118
1,2,3,4-TeMB		106.0	106.5	0.5	27	67	125
Surrogate		106.0	103.0	NA	NA	76	127

= Limits established 10/15/96, KSH
* = Values outside of QC limits.

RPD: 0 out of (10) outside limits.
Spike Recovery: 0 out of (20) outside limits.

Comments:

M Blecha
Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF06-MPG	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4081-02	Lab Project No.	: 96-4081
Date Sampled	: 11/18/96	Matrix	: Water
Date Received	: 11/19/96	Lab File No.	: HALL1125\024F0101
Date Prepared	: 11/25/96	Method Blank	: RB112596
Date Analyzed	: 11/25/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.[illegible]
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 71% 70% - 130% (QC limits)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4081.XLS; 11/27/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	:	W3	Client Project No.	:	729691.32010
Lab Sample No.	:	96-4081-04	Lab Project No.	:	96-4081
Date Sampled	:	11/18/96	Matrix	:	Water
Date Received	:	11/19/96	Lab File No.	:	HALL1125\027F0101
Date Prepared	:	11/25/96	Method Blank	:	RB112596
Date Analyzed	:	11/25/96	Dilution Factor	:	1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
[illegible]lorotoluene	106-49-8	U	0.4
[illegible]-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 76% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: W3 DUP	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4081-04 DUP	Lab Project No.	: 96-4081
Date Sampled	: 11/18/96	Matrix	: Water
Date Received	: 11/19/96	Lab File No.	: HALL1126\025F0101
Date Prepared	: 11/26/96	Method Blank	: RB112696
Date Analyzed	: 11/27/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 85% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF06-MPF(S)	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4081-05	Lab Project No.	: 96-4081
Date Sampled	: 11/18/96	Matrix	: Water
Date Received	: 11/19/96	Lab File No.	: HALL1125\026F0101
Date Prepared	: 11/25/96	Method Blank	: RB112596
Date Analyzed	: 11/25/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	E	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	4.2	0.4
1,2-Dichlorobenzene	95-50-1	4.9	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 105% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF06-MPF(S)	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4081-05	Lab Project No.	: 96-4081
Date Sampled	: 11/18/96	Matrix	: Water
Date Received	: 11/19/96	Lab File No.	: HALL1126\024F0101
Date Prepared	: 11/26/96	Method Blank	: RB112696
Date Analyzed	: 11/27/96	Dilution Factor	: 5.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Chlorobenzene	108-90-7	200	2.

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 95% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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QUANT REPORT Page 1

Operator ID: KIM Quant Rev: 7 Quant Time: 961127 20:18
Output File: ^V2967::Q1 Injected at: 961127 19:49
Data File: >V2967::V2 Dilution Factor: 1.00000
Name: 96-4081-05 ;;;KL Instrument ID: VOA 1
Misc: 5;W;0;1;W;0;11/22/96;0

ID File: ID_824::Q1
Title: ID FILE FOR APPENDIX NINE VOAs METHOD 8260A(8240)
Last Calibration: 961125 12:35 Last Qcal Time: <none>

	Compound	R.T.	Scan#	Area	Conc	Units	q
1)	*BROMOCHLOROMETHANE(INT STD)	6.13	583	32771	50.00	UG/L	78
4)	BROMOMETHANE	1.31	96	939	1.52	UG/L	100
23)	1,2 DICHLOROETHANE-D4(SUR STD)	7.45	716	82452	54.30	UG/L	100
24)	*1,4 DIFLUOROBENZENE(INT STD)	8.61	833	152415	50.00	UG/L	100
46)	*CHLOROBENZENE-D5(INTERNAL STD)	14.43	1420	124617	50.00	UG/L	100
55)	TOLUENE-D8(SURROGATE STD)	11.49	1123	165033	51.90	UG/L	100
55)	CHLOROBENZENE	14.47	1424	915283	357.12	UG/L	100
58)	BROMOFLUOROBENZENE(SURR STD)	17.05	1684	90788	52.26	UG/L	100
62)	1,3-DICHLOROBENZENE	19.36	1917	13372	6.20	UG/L	92
63)	1,2-DICHLOROBENZENE	20.35	2016	13593	6.57	UG/L	77
64)	1,4-DICHLOROBENZENE	19.59	1940	61171	26.94	UG/L	99

* Compound is ISTD

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF06-MPV	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4058-06	Lab Project No.	: 96-4081
Date Sampled	: 11/18/96	Matrix	: Water
Date Received	: 11/19/96	Lab File No.	: HALL1126\009F0101
Date Prepared	: 11/26/96	Method Blank	: RB112696
Date Analyzed	: 11/26/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	E	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	4.5	0.4
1,2-Dichlorobenzene	95-50-1	5.2	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 109% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF06-MPV	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4058-06	Lab Project No.	: 96-4081
Date Sampled	: 11/18/96	Matrix	: Water
Date Received	: 11/19/96	Lab File No.	: HALL1126\016F0101
Date Prepared	: 11/26/96	Method Blank	: RB112696
Date Analyzed	: 11/26/96	Dilution Factor	: 5.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Chlorobenzene	108-90-7	190	2.1

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 91% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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HLW4081.XLS; 11/27/96

QUANT REPORT

Operator ID: KIM
Output File: ^V2968::Q1
Data File: >V2968::V2
Name: 96-4081-06 ;;;KL
Misc: 5;W;0;1;W;0;11/27/96;0

Quant Rev: 7
Quant Time: 961127 20:52
Injected at: 961127 20:23
Dilution Factor: 1.00000
Instrument ID: VOA 1

ID File: ID_824::Q1
Title: ID FILE FOR APPENDIX NINE VOAs METHOD 8260A(8240)
Last Calibration: 961125 12:35
Last Qcal Time: <none>

	Compound	R.T.	Scan#	Area	Conc	Units	q
1)	*BROMOCHLOROMETHANE(INT STD)	6.16	586	33660	50.00	UG/L	[illegible]
4)	BROMOMETHANE	1.31	96	875	1.38	UG/L	[illegible]
23)	1,2 DICHLOROETHANE-D4(SUR STD)	7.48	719	82820	53.11	UG/L	[illegible]
24)	*1,4 DIFLUOROBENZENE(INT STD)	8.63	835	164914	50.00	UG/L	[illegible]
46)	*CHLOROBENZENE-D5(INTERNAL STD)	14.45	1422	136608	50.00	UG/L	[illegible]
53)	TOLUENE-D8(SURROGATE STD)	11.52	1126	176060	50.50	UG/L	[illegible]
55)	CHLOROBENZENE	14.50	1427	990999	352.73	UG/L	[illegible]
58)	BROMOFLUOROBENZENE(SURR STD)	17.06	1685	94543	49.69	UG/L	[illegible]
62)	1,3-DICHLOROBENZENE	19.38	1919	14389	6.10	UG/L	[illegible]
63)	1,2-DICHLOROBENZENE	20.39	2020	14683	6.47	UG/L	[illegible]
64)	1,4-DICHLOROBENZENE	19.61	1942	66086	26.55	UG/L	[illegible]

* Compound is ISTD

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF06-MPB	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4081-08	Lab Project No.	: 96-4081
Date Sampled	: 11/18/96	Matrix	: Water
Date Received	: 11/19/96	Lab File No.	: HALL1126\011F0101
Date Prepared	: 11/26/96	Method Blank	: RB112696
Date Analyzed	: 11/26/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 81% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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HLW4081.XLS; 11/27/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: LF06 Field Blank	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4081-10	Lab Project No.	: 96-4081
Date Sampled	: 11/18/96	Matrix	: Water
Date Received	: 11/19/96	Lab File No.	: HALL1126\023F0101
Date Prepared	: 11/26/96	Method Blank	: RB112696
Date Analyzed	: 11/27/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	[illegible]
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) : 85% 70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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HLW4081.XLS; 11/27/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: LF06-MPG	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4081-02	Lab Work Order	: 96-4081
Date Sampled	: 11/18/96	Dilution Factor	: 1.00
Date Received	: 11/19/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/22/96	Matrix	: Water
Date Analyzed	: 11/22/96	Lab File No.	: GAS1122023

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Temperature	:	68.8 F
Amount Injected	:	0.5 ml
Total Volume of Sample	:	43 ml
Head space created	:	4 ml
Methane Area	:	0 ug
Atomic weight(Methane)	:	16 g

Saturation Concentration	Meth	0
Concentration in Head Space	Meth	0

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: LF06-MPF(S)	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4081-05	Lab Work Order	: 96-4081
Date Sampled	: 11/18/96	Dilution Factor	: 50.00
Date Received	: 11/19/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/22/96	Matrix	: Water
Date Analyzed	: 11/22/96	Lab File No.	: GAS1122025

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	6.5	0.1

Temperature	:	69.1 F
Amount Injected	:	0.01 ml
Total Volume of Sample	:	43 ml
Head space created	:	4 ml
Methane Area	:	720.361 ug

Saturation Concentration	Meth	1.548[illegible]6
Concentration in Head Space	Meth	4.90690558

Atomic weight(Methane)	:	16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

Approved

AF4081.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: LF06-MPF(S)	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4081-05Dup	Lab Work Order	: 96-4081
Date Sampled	: 11/18/96	Dilution Factor	: 50.00
Date Received	: 11/19/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/22/96	Matrix	: Water
Date Analyzed	: 11/22/96	Lab File No.	: GAS1122026

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	6.6	0.1

[illegible]ature	:	69 F	Saturation Concentration	Meth	1.590635913
A[illegible]t Injected	:	0.01 ml			
Total Volume of Sample	:	43 ml	Concentration in Head Space	Meth	5.040197578
Head space created	:	4 ml			
Methane Area	:	739.789 ug			
Atomic weight(Methane)	:	16 g			

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA =Not Available/Not Applicable.

Analyst

K. Holman
Approved

AF4081.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: LF06-MPB	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4081-08	Lab Work Order	: 96-4081
Date Sampled	: 11/18/96	Dilution Factor	: 50.00
Date Received	: 11/19/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/22/96	Matrix	: Water
Date Analyzed	: 11/22/96	Lab File No.	: GAS1122028

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	4.7	0.1

Temperature	:	70.8 F
Amount Injected	:	0.01 ml
Total Volume of Sample	:	43 ml
Head space created	:	4 ml
Methane Area	:	523.143 ug

Saturation Concentration	Meth	1.124[illegible]8
Concentration in Head Space	Meth	3.552[illegible]4

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA =Not Available/Not Applicable.

Analyst

K. Hollman
Approved

AF4081.XLS

APPENDIX C

ANALYTICAL MODEL OUTPUT

Transient Solution to the Advective-Dispersive Equation for One-Dimensional Flow, Type Three Boundary Condition (0.048 mg/L source no decay, with a 0.0053 day-1 anaerobic decay coefficent, Constant Time, Variable Location)

Hydrogeologic Data

Hydraulic conductivtiy $K := 30.18 \cdot \frac{m}{day}$

Hydraulic gradient $I := 0.0055 \cdot \frac{ft}{ft}$

Effective porosity $n_e := 0.25$

Total porosity $n := 0.3$

Longitudinal dispersivity $\alpha_x := 30 \cdot m$

Concentration of Injected Contaminant $C_s := 0.048 \cdot \frac{mg}{liter}$

Initial Dissolved Contaminant Concentration $C_o := 0 \cdot \frac{mg}{liter}$

Retardation Coefficient Calculation

Solute Decay Rate $\lambda := 0.0053 \cdot \frac{1}{day}$

Source Decay Rate $\gamma := 0.00000 \cdot \frac{1}{day}$

Soil sorption coefficient (EPA, 1990) $K_{oc} := 79 \cdot \frac{mL}{gm}$

Bulk density (Freeze and Cherry, 1979) $\rho_b := 1.65 \cdot \frac{gm}{cm^3}$

Organic carbon content $f_{oc} := 0.06 \cdot \%$

Retardation coefficient $R := 1 + \frac{\rho_b \cdot K_{oc} \cdot f_{oc}}{n}$ $R = 1.261$

Groundwater Hydraulics Calculations

Groundwater velocity (pore-water) $v_x := \frac{K \cdot I}{n_e}$ $v_x = 0.664 \cdot \frac{m}{day}$

Contaminant velocity $v_c := \frac{v_x}{R}$ $v_c = 0.527 \cdot \frac{m}{day}$

Longitudinal dispersion coefficient $D_x := \alpha_x \cdot v_x$ $D_x = 214.404 \cdot \frac{ft^2}{day}$

1998 - Total BTEX Concentrations at Steady State

Initial Plume Distribution Calculation

$j := 0 .. 3000 \qquad t := 730 \cdot \mathrm{day}$

$\Delta x := 1 \cdot \mathrm{m}$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

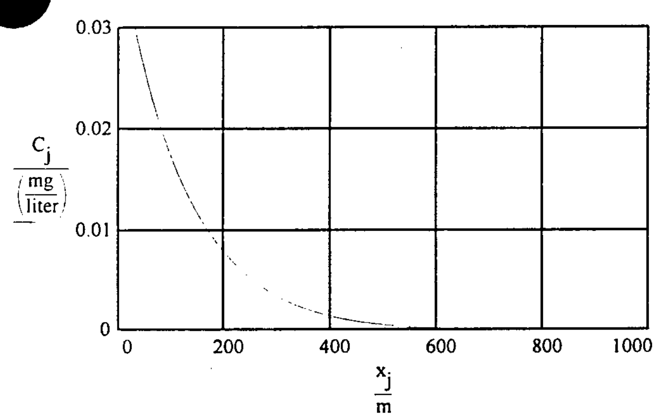
$$C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) - \left(\frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \right) \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t} \right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R} \right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x} \right) \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \mathrm{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

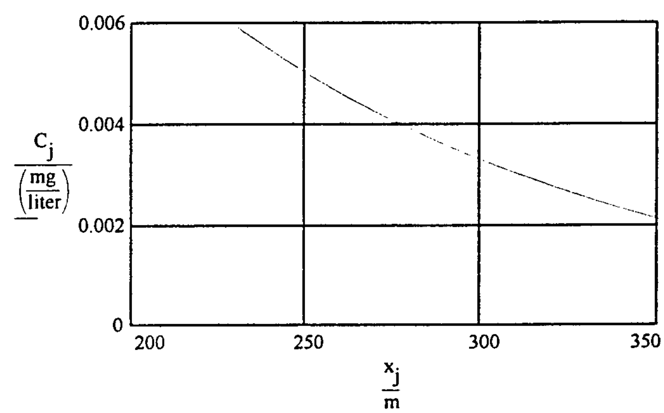
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \mathrm{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) \right]$$

Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Transient Solution to the Advective-Dispersive Equation for One-Dimensional Flow, Type Three Boundary Condition (0.048 mg/L source with no decay, a 0.0053 day-1 anaerobic decay coefficient, Constant Location, Variable Time)

Hydrogeologic Data

Hydraulic conductivtiy	$K := 30.18 \cdot \frac{m}{day}$
Hydraulic gradient	$I := 0.0055 \cdot \frac{ft}{ft}$
Effective porosity	$n_e := 0.25$
Total porosity	$n := 0.3$
Longitudinal dispersivity (EPRI, 1985)	$\alpha_x := 30 \cdot m$
Concentration of Injected Contaminant	$C_s := 0.048 \cdot \frac{mg}{liter}$
Initial Dissolved Contaminant Concentration	$C_o := 0 \cdot \frac{mg}{liter}$

Retardation Coefficient Calculation

Solute Decay Rate	$\lambda := 0.0053 \cdot \frac{1}{day}$	
Source Decay Rate	$\gamma := 0.00000 \cdot \frac{1}{day}$	
Soil sorption coefficient (EPA, 1990)	$K_{oc} := 79 \cdot \frac{mL}{gm}$	
Bulk density (Freeze and Cherry, 1979)	$\rho_b := 1.65 \cdot \frac{gm}{cm^3}$	
Organic carbon content	$f_{oc} := 0.06 \cdot \%$	
Retardation coefficient	$R := 1 + \frac{\rho_b \cdot K_{oc} \cdot f_{oc}}{n}$	$R = 1.261$

Groundwater Hydraulics Calculations

Groundwater velocity (pore-water)	$v_x := \frac{K \cdot I}{n_e}$	$v_x = 0.664 \cdot \frac{m}{day}$
Contaminant velocity	$v_c := \frac{v_x}{R}$	$v_c = 0.527 \cdot \frac{m}{day}$
Longitudinal dispersion coefficient	$D_x := \alpha_x \cdot v_x$	$D_x = 214.404 \cdot \frac{ft^2}{day}$

250 Meters Downgradient from Highest Total BTEX Concentration

Initial Plume Distribution Calculation

$year := 365 \cdot day \quad i := 1 .. 100 \qquad x := 250 \cdot m$

$\Delta t := 1 \cdot year$

$t_i := \Delta t \cdot i$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

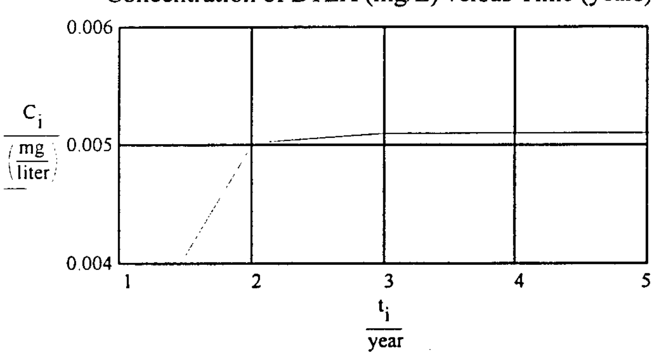
$$C_i := C_o \cdot \exp(-\lambda \cdot t_i) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x - v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) - \left(\frac{v_x^2 \cdot t_i}{\pi \cdot D_x \cdot R}\right) \cdot \exp\left[-\frac{(R \cdot x - v_x \cdot t_i)^2}{4 \cdot D_x \cdot R \cdot t_i}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x}{D_x} + \frac{v_x^2 \cdot t_i}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x}{D_x}\right) \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t_i) \cdot \Bigg[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right] \cdot x}{2 \cdot D_x}\right] \cdot \left[1 - \mathrm{erf}\left[\frac{R \cdot x - t_i \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right]}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right]\right] \ldots$$

$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right] \cdot x}{2 \cdot D_x}\right] \cdot \left[1 - \mathrm{erf}\left[\frac{R \cdot x + t_i \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right]\right] \ldots$$

$$+ \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)}\right] \cdot \exp\left[\frac{v_x \cdot x}{D_x} - (\lambda - \gamma) \cdot t_i\right] \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) \Bigg]$$

Concentration of BTEX (mg/L) versus Time (years)



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Transient Solution to the Advective-Dispersive Equation for One-Dimensional Flow, Type Three Boundary Condition (0.015 mg/L benzene source, no source decay, with a 0.0053 day-1 anaerobic decay coefficent, Constant Time, Variable Location)

Hydrogeologic Data

Hydraulic conductivtiy	$K := 30.18 \cdot \frac{m}{day}$
Hydraulic gradient	$I := 0.0055 \cdot \frac{ft}{ft}$
Effective porosity	$n_e := 0.25$
Total porosity	$n := 0.3$
Longitudinal dispersivity	$\alpha_x := 30 \cdot m$
Concentration of Injected Contaminant	$C_s := 0.015 \cdot \frac{mg}{liter}$
Initial Dissolved Contaminant Concentration	$C_0 := 0 \cdot \frac{mg}{liter}$

Retardation Coefficient Calculation

Solute Decay Rate	$\lambda := 0.0053 \cdot \frac{1}{day}$	
Source Decay Rate	$\gamma := 0.00000 \cdot \frac{1}{day}$	
Soil sorption coefficient (EPA, 1990)	$K_{oc} := 79 \cdot \frac{mL}{gm}$	
Bulk density (Freeze and Cherry, 1979)	$\rho_b := 1.65 \cdot \frac{gm}{cm^3}$	
Organic carbon content	$f_{oc} := 0.06 \cdot \%$	
Retardation coefficient	$R := 1 + \frac{\rho_b \cdot K_{oc} \cdot f_{oc}}{n}$	$R = 1.261$

Groundwater Hydraulics Calculations

Groundwater velocity (pore-water)	$v_x := \frac{K \cdot I}{n_e}$	$v_x = 0.664 \cdot \frac{m}{day}$
Contaminant velocity	$v_c := \frac{v_x}{R}$	$v_c = 0.527 \cdot \frac{m}{day}$
Longitudinal dispersion coefficient	$D_x := \alpha_x \cdot v_x$	$D_x = 214.404 \cdot \frac{ft^2}{day}$

1998 - Dissolved Benzene Concentrations at Steady State

Initial Plume Distribution Calculation

$j := 0..3000 \qquad t := 730 \cdot \text{day}$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

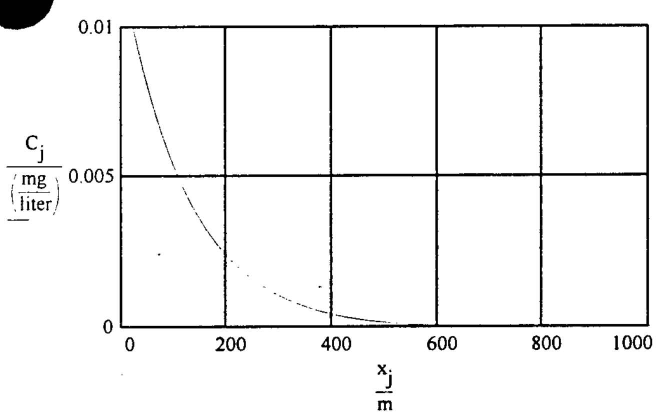
$$C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2}\cdot\left(1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2\cdot\sqrt{D_x \cdot R \cdot t}}\right)\right) - \left(\frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R}\right)\cdot \exp\left[-\frac{(R\cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t}\right] + \frac{1}{2}\cdot\left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R}\right)\cdot \exp\left(\frac{v_x \cdot x_j}{D_x}\right)\cdot\left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2\cdot\sqrt{D_x \cdot R \cdot t}}\right)\right)\right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2}\cdot(\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2}\cdot(\lambda - \gamma)}\right]\cdot x_j}{2 \cdot D_x}\right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2}\cdot(\lambda - \gamma)}\right]}{2\cdot\sqrt{D_x \cdot R \cdot t}}\right]\right] \ldots \right.$$

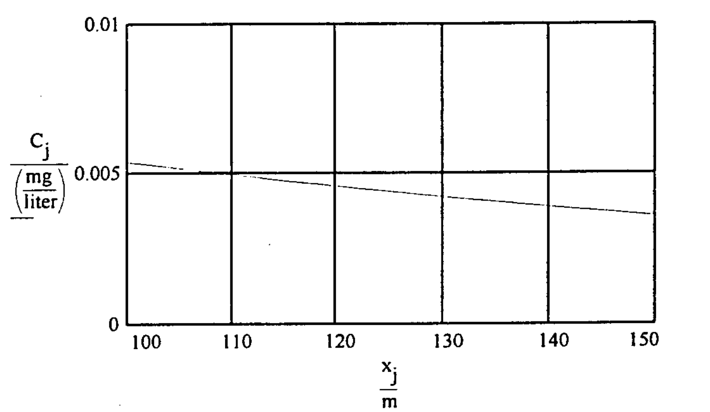
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2}\cdot(\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2}\cdot(\lambda - \gamma)}\right]\cdot x_j}{2 \cdot D_x}\right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2}\cdot(\lambda - \gamma)}}{2\cdot\sqrt{D_x \cdot R \cdot t}}\right]\right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)}\right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma)\cdot t\right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2\cdot\sqrt{D_x \cdot R \cdot t}}\right)\right) \right]$$

Dissolved Benzene (mg/L) Concentration versus Distance (m)



Dissolved Benzene (mg/L) Concentration versus Distance (m)



Transient Solution to the Advective-Dispersive Equation for One-Dimensional Flow, Type Three Boundary Condition (0.015 mg/L benzene source with no decay, a 0.0053 day-1 anaerobic decay coefficient, Constant Location, Variable Time)

Hydrogeologic Data

Hydraulic conductivtiy	$K := 30.18 \cdot \frac{m}{day}$	
Hydraulic gradient	$I := 0.0055 \cdot \frac{ft}{ft}$	
Effective porosity	$n_e := 0.25$	
Total porosity	$n := 0.3$	
Longitudinal dispersivity (EPRI, 1985)	$\alpha_x := 30 \cdot m$	
Concentration of Injected Contaminant	$C_s := 0.015 \cdot \frac{mg}{liter}$	
Initial Dissolved Contaminant Concentration	$C_o := 0 \cdot \frac{mg}{liter}$	

Retardation Coefficient Calculation

Solute Decay Rate	$\lambda := 0.0053 \cdot \frac{1}{day}$	
Source Decay Rate	$\gamma := 0.00000 \cdot \frac{1}{day}$	
Soil sorption coefficient (EPA, 1990)	$K_{oc} := 79 \cdot \frac{mL}{gm}$	
Bulk density (Freeze and Cherry, 1979)	$\rho_b := 1.65 \cdot \frac{gm}{cm^3}$	
Organic carbon content	$f_{oc} := 0.06 \cdot \%$	
Retardation coefficient	$R := 1 + \frac{\rho_b \cdot K_{oc} \cdot f_{oc}}{n}$	$R = 1.261$

Groundwater Hydraulics Calculations

Groundwater velocity (pore-water)	$v_x := \frac{K \cdot I}{n_e}$	$v_x = 0.664 \cdot \frac{m}{day}$
Contaminant velocity	$v_c := \frac{v_x}{R}$	$v_c = 0.527 \cdot \frac{m}{day}$
Longitudinal dispersion coefficient	$D_x := \alpha_x \cdot v_x$	$D_x = 214.404 \cdot \frac{ft^2}{day}$

110 Meters Downgradient from the Highest Observed Benzene Concentration

<u>nitial Plume Distribution Calculation</u>

$year \equiv 365 \cdot day \quad i := 1 .. 120 \qquad x := 110 \cdot m$

$\Delta t := 1 \cdot year$

$t_i := \Delta t \cdot i$

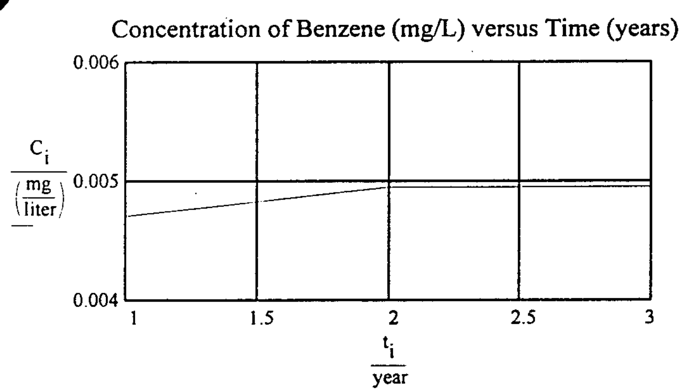
For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

$$C_i := C_0 \cdot \exp(-\lambda \cdot t_i) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x - v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}} \right) \right) - \left(\frac{v_x^2 \cdot t_i}{\pi \cdot D_x \cdot R} \right) \cdot \exp\left[-\frac{(R \cdot x - v_x \cdot t_i)^2}{4 \cdot D_x \cdot R \cdot t_i} \right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x}{D_x} + \frac{v_x^2 \cdot t_i}{D_x \cdot R} \right) \cdot \exp\left(\frac{v_x \cdot x}{D_x} \right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}} \right) \right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t_i) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x - t_i \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}} \right] \right] \ldots \right.$$

$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x + t_i \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x}{D_x} - (\lambda - \gamma) \cdot t_i \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}} \right) \right) \right]$$



Transient Solution to the Advective-Dispersive Equation for One-Dimensional Flow, Type Three Boundary Condition (0.200 mg/L chlorobenzene source with no decay, with a 0.010 day-1 anaerobic decay coefficent, Constant Time, Variable Location)

Hydrogeologic Data

Hydraulic conductivtiy	$K := 30.18 \cdot \frac{m}{day}$	
Hydraulic gradient	$I := 0.0055 \cdot \frac{ft}{ft}$	
Effective porosity	$n_e := 0.25$	
Total porosity	$n := 0.3$	
Longitudinal dispersivity	$\alpha_x := 30 \cdot m$	
Concentration of Injected Contaminant	$C_s := 0.200 \cdot \frac{mg}{liter}$	
Initial Dissolved Contaminant Concentration	$C_o := 0 \cdot \frac{mg}{liter}$	

Retardation Coefficient Calculation

Solute Decay Rate	$\lambda := 0.010 \cdot \frac{1}{day}$	
Source Decay Rate	$\gamma := 0.00000 \cdot \frac{1}{day}$	
Soil sorption coefficient (EPA, 1990)	$K_{oc} := 79 \cdot \frac{mL}{gm}$	
Bulk density (Freeze and Cherry, 1979)	$\rho_b := 1.65 \cdot \frac{gm}{cm^3}$	
Organic carbon content	$f_{oc} := 0.06 \cdot \%$	
Retardation coefficient	$R := 1 + \frac{\rho_b \cdot K_{oc} \cdot f_{oc}}{n}$	$R = 1.261$

Groundwater Hydraulics Calculations

Groundwater velocity (pore-water)	$v_x := \frac{K \cdot I}{n_e}$	$v_x = 0.664 \cdot \frac{m}{day}$
Contaminant velocity	$v_c := \frac{v_x}{R}$	$v_c = 0.527 \cdot \frac{m}{day}$
Longitudinal dispersion coefficient	$D_x := \alpha_x \cdot v_x$	$D_x = 214.404 \cdot \frac{ft^2}{day}$

1998 - Dissolved Chlorobenzene Concentrations at Steady State

Initial Plume Distribution Calculation

$j := 0..3000 \qquad t := 730\cdot day$

$\Delta x := 1\cdot m$

$x_j := \Delta x\cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

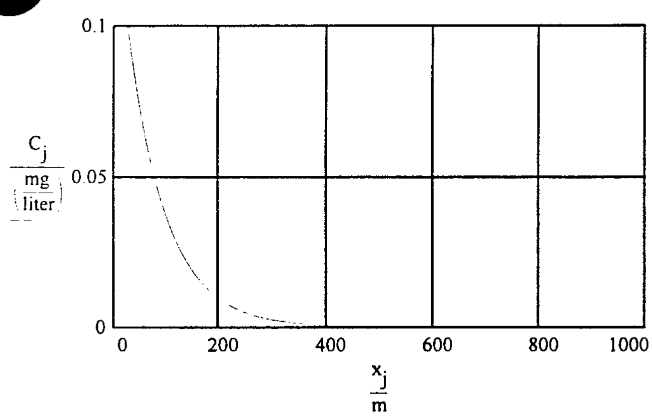
$$C_j := C_o\cdot\exp(-\lambda\cdot t)\cdot\left[1-\frac{1}{2}\cdot\left(1-\operatorname{erf}\left(\frac{R\cdot x_j-v_x\cdot t}{2\cdot\sqrt{D_x\cdot R\cdot t}}\right)\right)-\left(\frac{v_x^{2}\cdot t}{\pi\cdot D_x\cdot R}\right)\cdot\exp\left[-\frac{(R\cdot x_j-v_x\cdot t)^2}{4\cdot D_x\cdot R\cdot t}\right]+\frac{1}{2}\cdot\left(1+\frac{v_x\cdot x_j}{D_x}+\frac{v_x^{2}\cdot t}{D_x\cdot R}\right)\cdot\exp\left(\frac{v_x\cdot x_j}{D_x}\right)\cdot\left(1-\operatorname{erf}\left(\frac{R\cdot x_j-v_x\cdot t}{2\cdot\sqrt{D_x\cdot R\cdot t}}\right)\right)\right]\ldots$$

$$+C_s\cdot\exp(-\gamma\cdot t)\cdot\left[\left[\frac{v_x}{v_x+v_x\cdot\sqrt{1+\frac{4\cdot D_x\cdot R}{v_x^{2}}\cdot(\lambda-\gamma)}}\right]\cdot\exp\left[\frac{\left[v_x-v_x\cdot\sqrt{1+\frac{4\cdot D_x\cdot R}{v_x^{2}}\cdot(\lambda-\gamma)}\right]\cdot x_j}{2\cdot D_x}\right]\cdot\left[1-\operatorname{erf}\left[\frac{R\cdot x_j-t\cdot\left[v_x\cdot\sqrt{1+\frac{4\cdot D_x\cdot R}{v_x^{2}}\cdot(\lambda-\gamma)}\right]}{2\cdot\sqrt{D_x\cdot R\cdot t}}\right]\right]\ldots\right.$$

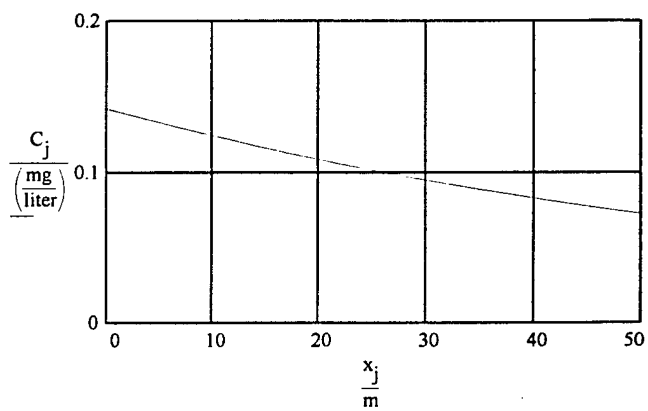
$$+\left[\frac{v_x}{v_x-v_x\cdot\sqrt{1+\frac{4\cdot D_x\cdot R}{v_x^{2}}\cdot(\lambda-\gamma)}}\right]\cdot\exp\left[\frac{\left[v_x+v_x\cdot\sqrt{1+\frac{4\cdot D_x\cdot R}{v_x^{2}}\cdot(\lambda-\gamma)}\right]\cdot x_j}{2\cdot D_x}\right]\cdot\left[1-\operatorname{erf}\left[\frac{R\cdot x_j+t\cdot v_x\cdot\sqrt{1+\frac{4\cdot D_x\cdot R}{v_x^{2}}\cdot(\lambda-\gamma)}}{2\cdot\sqrt{D_x\cdot R\cdot t}}\right]\right]\ldots$$

$$\left.+\left[\frac{v_x^{2}}{2\cdot D_x\cdot R\cdot(\lambda-\gamma)}\right]\cdot\exp\left[\frac{v_x\cdot x_j}{D_x}-(\lambda-\gamma)\cdot t\right]\cdot\left(1-\operatorname{erf}\left(\frac{R\cdot x_j+v_x\cdot t}{2\cdot\sqrt{D_x\cdot R\cdot t}}\right)\right)\right]$$

ssolved Chlorobenzene (mg/L) Concentration versus Distance (m)



Dissolved Chlorobenzene (mg/L) Concentration versus Distanc



Transient Solution to the Advective-Dispersive Equation for One-Dimensional Flow, Type Three Boundary Condition (0.200 mg/L chlorobenzene source with no decay, a 0.010 day-1 anaerobic decay coefficient, Constant Location, Variable Time)

Hydrogeologic Data

Hydraulic conductivtiy	$K := 30.18 \cdot \frac{m}{day}$
Hydraulic gradient	$I := 0.0055 \cdot \frac{ft}{ft}$
Effective porosity	$n_e := 0.25$
Total porosity	$n := 0.3$
Longitudinal dispersivity (EPRI, 1985)	$\alpha_x := 30 \cdot m$
Concentration of Injected Contaminant	$C_s := 0.200 \cdot \frac{mg}{liter}$
Initial Dissolved Contaminant Concentration	$C_o := 0 \cdot \frac{mg}{liter}$

Retardation Coefficient Calculation

Solute Decay Rate	$\lambda := 0.01 \cdot \frac{1}{day}$	
Source Decay Rate	$\gamma := 0.00000 \cdot \frac{1}{day}$	
Soil sorption coefficient (EPA, 1990)	$K_{oc} := 79 \cdot \frac{mL}{gm}$	
Bulk density (Freeze and Cherry, 1979)	$\rho_b := 1.65 \cdot \frac{gm}{cm^3}$	
Organic carbon content	$f_{oc} := 0.06 \cdot \%$	
Retardation coefficient	$R := 1 + \frac{\rho_b \cdot K_{oc} \cdot f_{oc}}{n}$	$R = 1.261$

Groundwater Hydraulics Calculations

Groundwater velocity (pore-water)	$v_x := \frac{K \cdot I}{n_e}$	$v_x = 0.664 \cdot \frac{m}{day}$
Contaminant velocity	$v_c := \frac{v_x}{R}$	$v_c = 0.527 \cdot \frac{m}{day}$
Longitudinal dispersion coefficient	$D_x := \alpha_x \cdot v_x$	$D_x = 214.404 \cdot \frac{ft^2}{day}$

30 Meters Downgradient from Highest Observed Chlorobenzne Concentration

Initial Plume Distribution Calculation

$year := 365 \cdot day \qquad i := 1 .. 120 \qquad x := 30 \cdot m$

$\Delta t := 1 \cdot year$

$t_i := \Delta t \cdot i$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

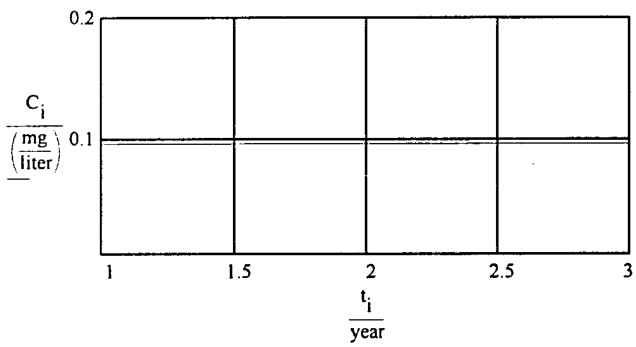
$$C_i := C_0 \cdot \exp(-\lambda \cdot t_i) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x - v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) - \left(\frac{v_x^2 \cdot t_i}{\pi \cdot D_x \cdot R}\right) \cdot \exp\left[-\frac{(R \cdot x - v_x \cdot t_i)^2}{4 \cdot D_x \cdot R \cdot t_i}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x}{D_x} + \frac{v_x^2 \cdot t_i}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x}{D_x}\right) \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right)\right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t_i) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right] \cdot x}{2 \cdot D_x}\right] \cdot \left[1 - \mathrm{erf}\left[\frac{R \cdot x - t_i \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right]}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right]\right] \ldots \right.$$

$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right] \cdot x}{2 \cdot D_x}\right] \cdot \left[1 - \mathrm{erf}\left[\frac{R \cdot x + t_i \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right]\right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)}\right] \cdot \exp\left[\frac{v_x \cdot x}{D_x} - (\lambda - \gamma) \cdot t_i\right] \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) \right]$$

Concentration of Chlorobenzene (mg/L) versus Time (years)



Transient Solution to the Advective-Dispersive Equation for One-Dimensional Flow, Type Three Boundary Condition (0.0075 mg/L TCE source with no decay, with a 0.0035 day-1 reductive dehaslogenation coefficent, Constant Time, Variable Location)

Hydrogeologic Data

Hydraulic conductivtiy	$K := 30.18 \cdot \frac{m}{day}$
Hydraulic gradient	$I := 0.0055 \cdot \frac{ft}{ft}$
Effective porosity	$n_e := 0.25$
Total porosity	$n := 0.3$
Longitudinal dispersivity	$\alpha_x := 30 \cdot m$
Concentration of Injected Contaminant	$C_s := 0.0075 \cdot \frac{mg}{liter}$
Initial Dissolved Contaminant Concentration	$C_o := 0 \cdot \frac{mg}{liter}$

Retardation Coefficient Calculation

Solute Decay Rate	$\lambda := 0.0035 \cdot \frac{1}{day}$	
Source Decay Rate	$\gamma := 0.00000 \cdot \frac{1}{day}$	
Soil sorption coefficient (EPA, 1990)	$K_{oc} := 72 \cdot \frac{mL}{gm}$	
Bulk density (Freeze and Cherry, 1979)	$\rho_b := 1.65 \cdot \frac{gm}{cm^3}$	
Organic carbon content	$f_{oc} := 0.06 \cdot \%$	
Retardation coefficient	$R := 1 + \frac{\rho_b \cdot K_{oc} \cdot f_{oc}}{n}$	$R = 1.238$

Groundwater Hydraulics Calculations

Groundwater velocity (pore-water)	$v_x := \frac{K \cdot I}{n_e}$	$v_x = 0.664 \cdot \frac{m}{day}$
Contaminant velocity	$v_c := \frac{v_x}{R}$	$v_c = 0.536 \cdot \frac{m}{day}$
Longitudinal dispersion coefficient	$D_x := \alpha_x \cdot v_x$	$D_x = 214.404 \cdot \frac{ft^2}{day}$

1998 - Dissolved TCE Concetrations at Steady State

Initial Plume Distribution Calculation

$j := 0 .. 3000$ $\qquad t := 730 \cdot day$

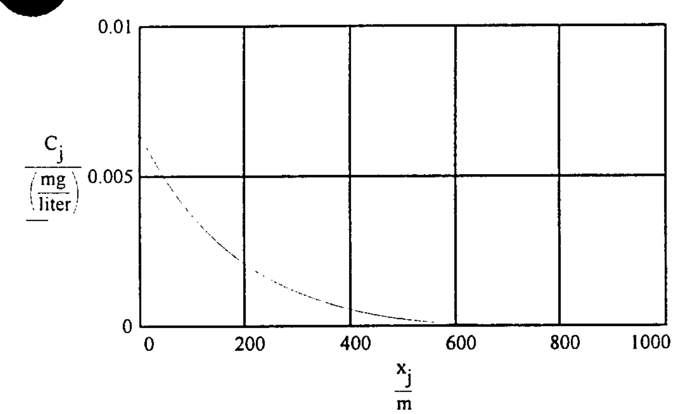
$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

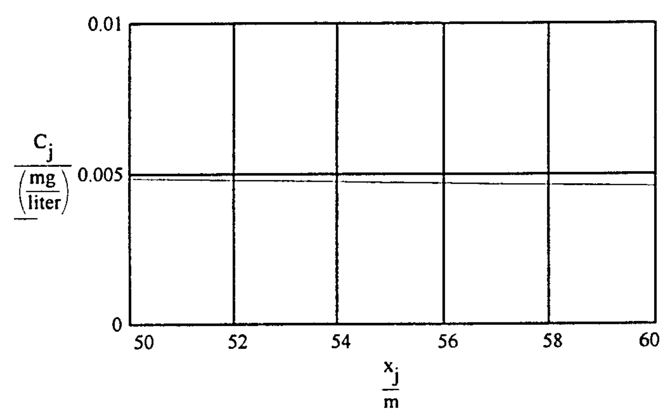
For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

$$
\begin{aligned}
C_j := {} & C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) - \left(\frac{v_x{}^2 \cdot t}{\pi \cdot D_x \cdot R} \right) \cdot \exp\left[-\frac{\left(R \cdot x_j - v_x \cdot t\right)^2}{4 \cdot D_x \cdot R \cdot t} \right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x{}^2 \cdot t}{D_x \cdot R} \right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x} \right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) \right] \ldots \\
& + C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x{}^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x{}^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x{}^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right. \\
& \quad + \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x{}^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x{}^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x{}^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \\
& \quad \left. + \left[\frac{v_x{}^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) \right]
\end{aligned}
$$

Dissolved TCE (mg/L) Concentration versus Distance (m)



Dissolved TCE (mg/L) Concentration versus Distance (m)



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Transient Solution to the Advective-Dispersive Equation for One-Dimensional Flow, Type Three Boundary Condition (0.0075 mg/L TCE source with no decay, a 0.0035 day-1 reductive dehalogenation decay coefficient, Constant Location, Variable Time)

Hydrogeologic Data

Hydraulic conductivtiy	$K := 30.18 \cdot \frac{m}{day}$	
Hydraulic gradient	$I := 0.0055 \cdot \frac{ft}{ft}$	
Effective porosity	$n_e := 0.25$	
Total porosity	$n := 0.3$	
Longitudinal dispersivity (EPRI, 1985)	$\alpha_x := 30 \cdot m$	
Concentration of Injected Contaminant	$C_s := 0.0075 \cdot \frac{mg}{liter}$	
Initial Dissolved Contaminant Concentration	$C_o := 0 \cdot \frac{mg}{liter}$	

Retardation Coefficient Calculation

Solute Decay Rate	$\lambda := 0.0035 \cdot \frac{1}{day}$	
Source Decay Rate	$\gamma := 0.00000 \cdot \frac{1}{day}$	
Soil sorption coefficient (EPA, 1990)	$K_{oc} := 72 \cdot \frac{mL}{gm}$	
Bulk density (Freeze and Cherry, 1979)	$\rho_b := 1.65 \cdot \frac{gm}{cm^3}$	
Organic carbon content	$f_{oc} := 0.06 \cdot \%$	
Retardation coefficient	$R := 1 + \frac{\rho_b \cdot K_{oc} \cdot f_{oc}}{n}$	$R = 1.238$

Groundwater Hydraulics Calculations

Groundwater velocity (pore-water)	$v_x := \frac{K \cdot I}{n_e}$	$v_x = 0.664 \cdot \frac{m}{day}$
Contaminant velocity	$v_c := \frac{v_x}{R}$	$v_c = 0.536 \cdot \frac{m}{day}$
Longitudinal dispersion coefficient	$D_x := \alpha_x \cdot v_x$	$D_x = 214.404 \cdot \frac{ft^2}{day}$

65 Meters Downgradient from Highest Observed TCE Concentration

nitial Plume Distribution Calculation

$year := 365 \cdot day \qquad i := 1 .. 120 \qquad x := 50 \cdot m$

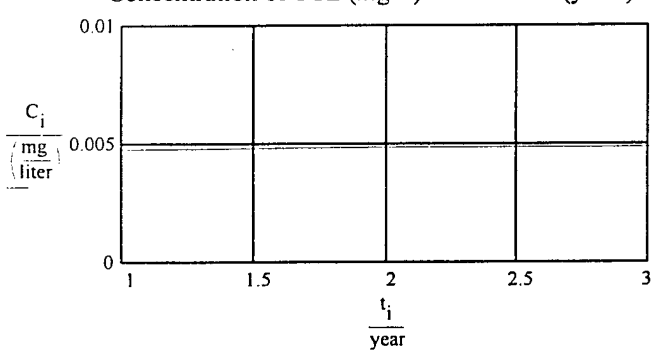
$\Delta t := 1 \cdot year$

$t_i := \Delta t \cdot i$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

$$
\begin{aligned}
C_i := {} & C_o \cdot \exp(-\lambda \cdot t_i) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x - v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) - \left(\frac{{v_x}^2 \cdot t_i}{\pi \cdot D_x \cdot R}\right) \cdot \exp\left[-\frac{(R \cdot x - v_x \cdot t_i)^2}{4 \cdot D_x \cdot R \cdot t_i}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x}{D_x} + \frac{{v_x}^2 \cdot t_i}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x}{D_x}\right) \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right)\right] \ldots \\
& + C_s \cdot \exp(-\gamma \cdot t_i) \cdot \Bigg[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{{v_x}^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{{v_x}^2} \cdot (\lambda - \gamma)}\right] \cdot x}{2 \cdot D_x}\right] \cdot \left[1 - \mathrm{erf}\left[\frac{R \cdot x - t_i \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{{v_x}^2} \cdot (\lambda - \gamma)}\right]}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right]\right] \ldots \\
& + \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{{v_x}^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{{v_x}^2} \cdot (\lambda - \gamma)}\right] \cdot x}{2 \cdot D_x}\right] \cdot \left[1 - \mathrm{erf}\left[\frac{R \cdot x + t_i \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{{v_x}^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right]\right] \ldots \\
& + \left[\frac{{v_x}^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)}\right] \cdot \exp\left[\frac{v_x \cdot x}{D_x} - (\lambda - \gamma) \cdot t_i\right] \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right)\Bigg]
\end{aligned}
$$

Concentration of TCE (mg/L) versus Time (years)



Transient Solution to the Advective-Dispersive Equation for One-Dimensional Flow, Type Three Boundary Condition (0.010 mg/L VC source with no decay, with a 0.0035 day-1 reductive dehalogenation decay coefficent, Constant Time, Variable Location)

rogeologic Data

Hydraulic conductivtiy $K := 30.18 \cdot \frac{m}{day}$

Hydraulic gradient $I := 0.0055 \cdot \frac{ft}{ft}$

Effective porosity $n_e := 0.25$

Total porosity $n := 0.3$

Longitudinal dispersivity $\alpha_x := 30 \cdot m$

Concentration of Injected Contaminant $C_s := 0.010 \cdot \frac{mg}{liter}$

Initial Dissolved Contaminant Concentration $C_o := 0 \cdot \frac{mg}{liter}$

Retardation Coefficient Calculation

Solute Decay Rate $\lambda := 0.0035 \cdot \frac{1}{day}$

Source Decay Rate $\gamma := 0.00000 \cdot \frac{1}{day}$

il sorption coefficient (EPA, 1990) $K_{oc} := 2.45 \cdot \frac{mL}{gm}$

Bulk density (Freeze and Cherry, 1979) $\rho_b := 1.65 \cdot \frac{gm}{cm^3}$

Organic carbon content $f_{oc} := 0.06 \cdot \%$

Retardation coefficient $R := 1 + \frac{\rho_b \cdot K_{oc} \cdot f_{oc}}{n}$ $R = 1.008$

Groundwater Hydraulics Calculations

Groundwater velocity (pore-water) $v_x := \frac{K \cdot I}{n_e}$ $v_x = 0.664 \cdot \frac{m}{day}$

Contaminant velocity $v_c := \frac{v_x}{R}$ $v_c = 0.659 \cdot \frac{m}{day}$

Longitudinal dispersion coefficient $D_x := \alpha_x \cdot v_x$ $D_x = 214.404 \cdot \frac{ft^2}{day}$

1998 - Disssolved VC Concentrations at Steady State

Initial Plume Distribution Calculation

$j := 0 .. 3000 \qquad t := 730 \cdot day$

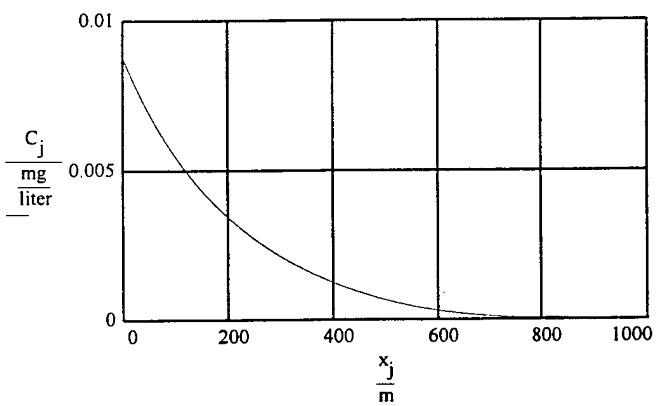
$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

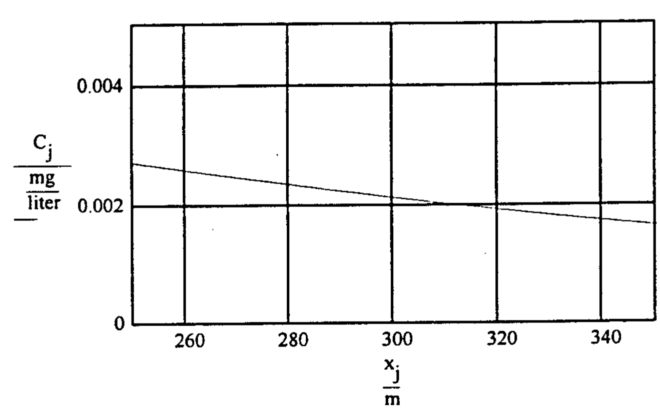
For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

$$
\begin{aligned}
C_j := {} & C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t} \right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R} \right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x} \right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) \right] \ldots \\
& + C_s \cdot \exp(-\gamma \cdot t) \cdot \Bigg[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \\
& + \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \\
& + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) \Bigg]
\end{aligned}
$$

Dissolved VC (mg/L) Concentration versus Distance (m)



Dissolved VC (mg/L) Concentration versus Distance (m)



Transient Solution to the Advective-Dispersive Equation for One-Dimensional Flow, Type Three Boundary Condition (0.010 mg/L VC source with no decay, a 0.0035 day-1 reductive dehalogenation decay coefficient, Constant Location, Variable Time)

ogeologic Data

Hydraulic conductivtiy	$K := 30.18 \cdot \frac{m}{day}$
Hydraulic gradient	$I := 0.0055 \cdot \frac{ft}{ft}$
Effective porosity	$n_e := 0.25$
Total porosity	$n := 0.3$
Longitudinal dispersivity (EPRI, 1985)	$\alpha_x := 30 \cdot m$
Concentration of Injected Contaminant	$C_s := 0.010 \cdot \frac{mg}{liter}$
Initial Dissolved Contaminant Concentration	$C_o := 0 \cdot \frac{mg}{liter}$

Retardation Coefficient Calculation

Solute Decay Rate	$\lambda := 0.0035 \cdot \frac{1}{day}$	
Source Decay Rate	$\gamma := 0.00000 \cdot \frac{1}{day}$	
l sorption coefficient (EPA, 1990)	$K_{oc} := 2.45 \cdot \frac{mL}{gm}$	
Bulk density (Freeze and Cherry, 1979)	$\rho_b := 1.65 \cdot \frac{gm}{cm^3}$	
Organic carbon content	$f_{oc} := 0.06 \cdot \%$	
Retardation coefficient	$R := 1 + \frac{\rho_b \cdot K_{oc} \cdot f_{oc}}{n}$	$R = 1.008$

Groundwater Hydraulics Calculations

Groundwater velocity (pore-water)	$v_x := \frac{K \cdot I}{n_e}$	$v_x = 0.664 \cdot \frac{m}{day}$
Contaminant velocity	$v_c := \frac{v_x}{R}$	$v_c = 0.659 \cdot \frac{m}{day}$
ngitudinal dispersion coefficient	$D_x := \alpha_x \cdot v_x$	$D_x = 214.404 \cdot \frac{ft^2}{day}$

310 meter downgradient from the source area

Initial Plume Distribution Calculation

$year := 365 \cdot day \qquad i := 1 .. 120 \qquad x := 310 \cdot m$

$\Delta t := 1 \cdot year$

$t_i := \Delta t \cdot i$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

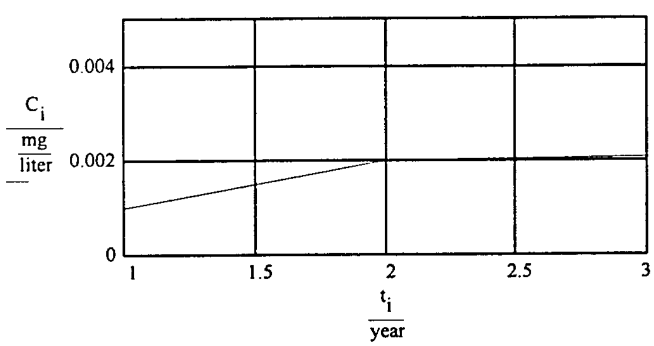
$$C_i := C_o \cdot \exp\left(-\lambda \cdot t_i\right) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x - v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) - \frac{v_x^{2} \cdot t_i}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{\left(R \cdot x - v_x \cdot t_i\right)^2}{4 \cdot D_x \cdot R \cdot t_i}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x}{D_x} + \frac{v_x^{2} \cdot t_i}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right)\right] \ldots$$

$$+ C_s \cdot \exp\left(-\gamma \cdot t_i\right) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^{2}} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^{2}} \cdot (\lambda - \gamma)}\right] \cdot x}{2 \cdot D_x}\right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x - t_i \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^{2}} \cdot (\lambda - \gamma)}\right]}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right]\right] \ldots\right.$$

$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^{2}} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^{2}} \cdot (\lambda - \gamma)}\right] \cdot x}{2 \cdot D_x}\right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x + t_i \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^{2}} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right]\right] \ldots$$

$$\left. + \left[\frac{v_x^{2}}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)}\right] \cdot \exp\left[\frac{v_x \cdot x}{D_x} - (\lambda - \gamma) \cdot t_i\right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right)\right]$$

Concentration of BTEX (mg/L) versus Time (years)



Sensitivity Analysis of Hydrualic Conductivity (2 times less than observed value)

Initial Plume Distribution Calculation

$j := 0..3000 \qquad t := 730 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

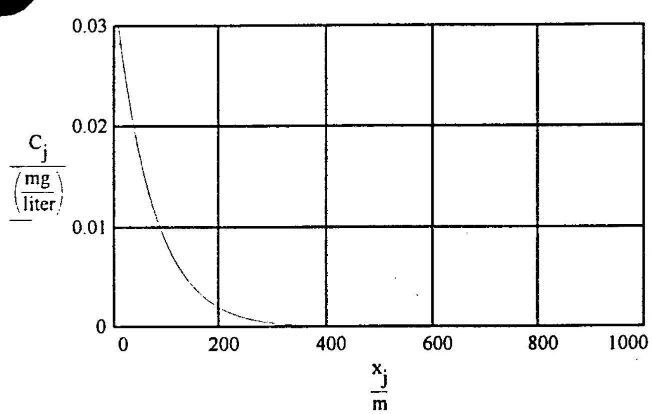
$$C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) - \left(\frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R}\right) \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right)\right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right] \cdot x_j}{2 \cdot D_x}\right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right]\right] \ldots\right.$$

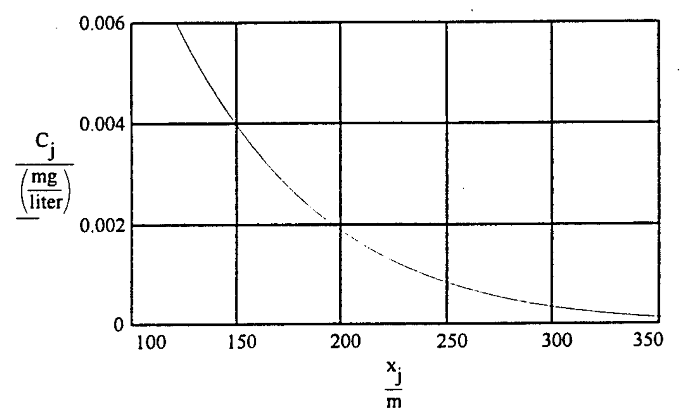
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right] \cdot x_j}{2 \cdot D_x}\right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right]\right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)}\right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t\right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right)\right]$$

Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Sensitivity Analysis of Hydrualic Conductivity (2 times greater than observed value)

Initial Plume Distribution Calculation

$j := 0 .. 3000 \qquad t := 730 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

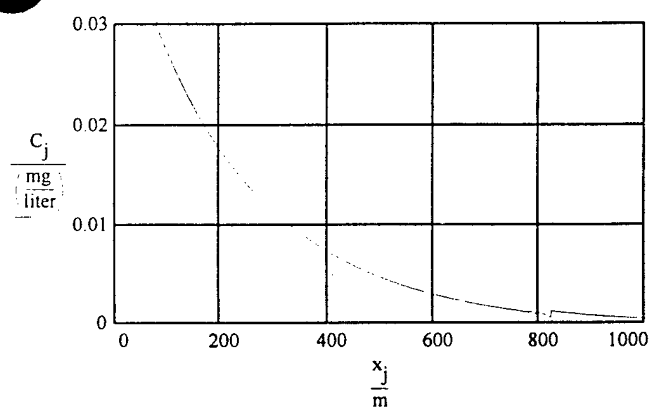
$$C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) - \left(\frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R}\right) \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right)\right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right] \cdot x_j}{2 \cdot D_x}\right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right]\right] \ldots\right.$$

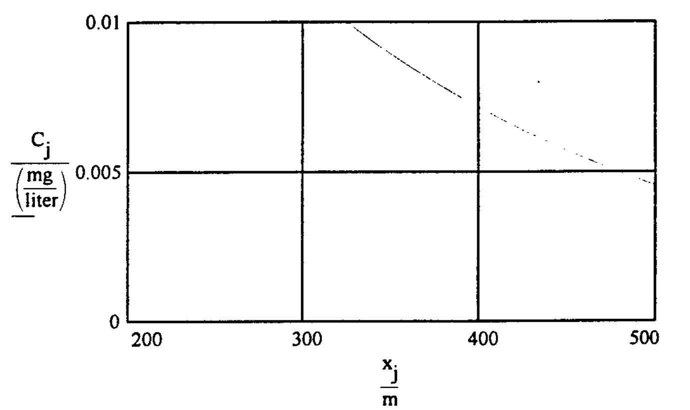
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right] \cdot x_j}{2 \cdot D_x}\right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right]\right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)}\right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t\right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right)\right]$$

Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



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Sensitivity Analysis of Effective Porosity (25 percent more than observed value)

Initial Plume Distribution Calculation

$j := 0 .. 3000 \qquad t := 730 \cdot \mathrm{day}$

$\Delta x := 1 \cdot \mathrm{m}$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

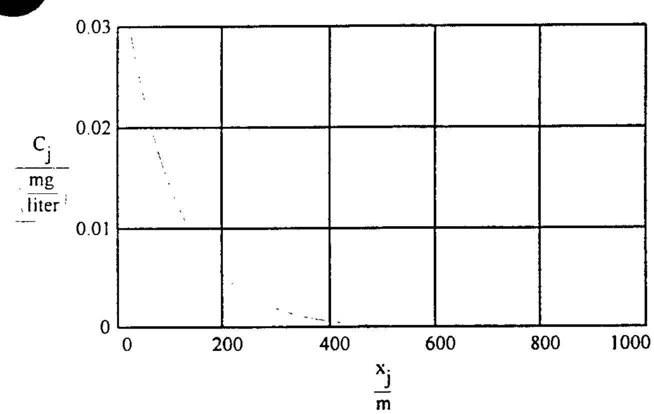
$$C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) - \left(\frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \right) \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t} \right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R} \right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x} \right) \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \mathrm{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

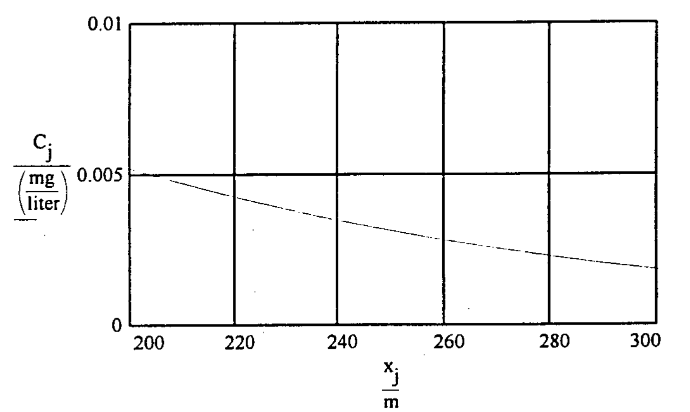
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \mathrm{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) \right]$$

Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Sensitivity Analysis of Effective Porosity (25 percent less than observed value)

Initial Plume Distribution Calculation

$j := 0..3000 \qquad t := 730 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

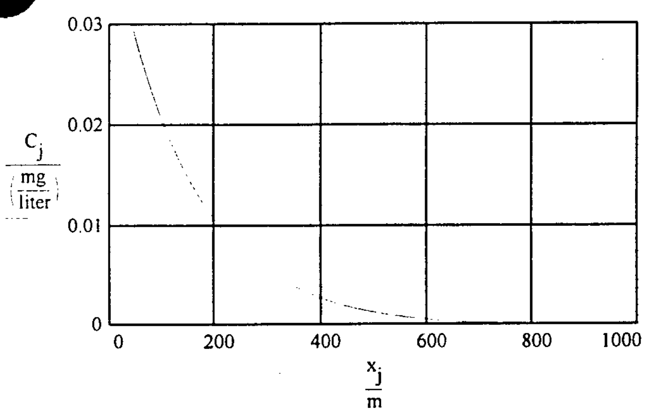
$$C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) - \left(\frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R}\right) \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x}\right) \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right)\right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right] \cdot x_j}{2 \cdot D_x}\right] \cdot \left[1 - \mathrm{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right]\right] \ldots\right.$$

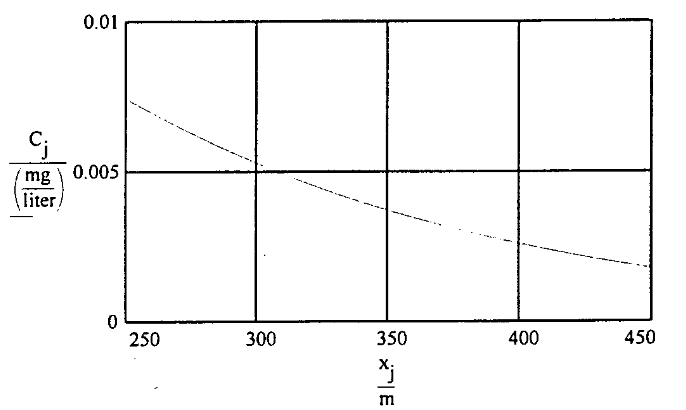
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right] \cdot x_j}{2 \cdot D_x}\right] \cdot \left[1 - \mathrm{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right]\right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)}\right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t\right] \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right)\right]$$

Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Sensitivity Analysis of Solute Decay (2 times greater than calcaulated value)

Initial Plume Distribution Calculation

$j := 0..3000$ $\qquad t := 730 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

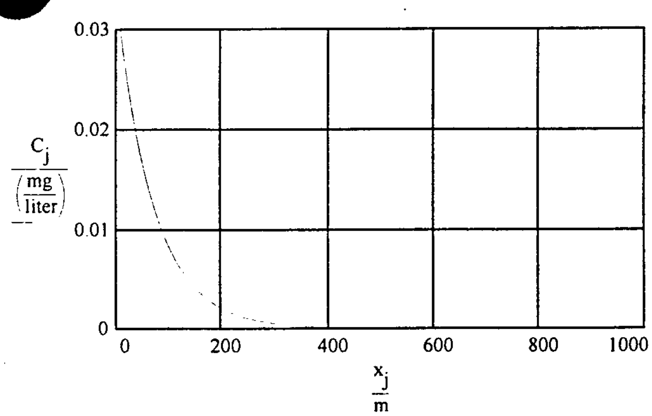
$$C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) - \left(\frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R}\right) \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x}\right) \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right)\right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right] \cdot x_j}{2 \cdot D_x}\right] \cdot \left[1 - \mathrm{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right]\right] \ldots\right.$$

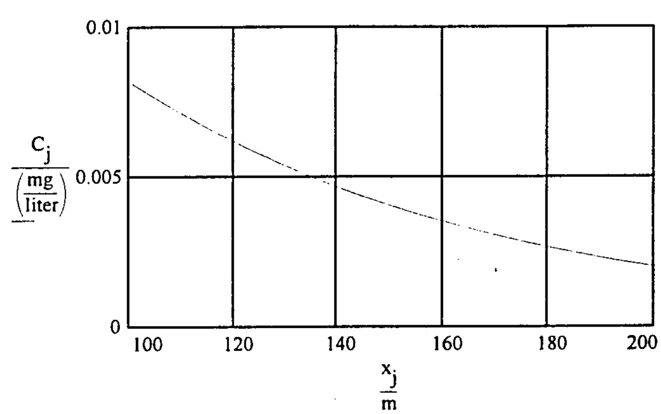
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right] \cdot x_j}{2 \cdot D_x}\right] \cdot \left[1 - \mathrm{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right]\right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)}\right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t\right] \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right)\right]$$

Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Sensitivity Analysis of Solute Decay (2 times less than calcaulated value)

Initial Plume Distribution Calculation

$j := 0..3000 \qquad t := 730\cdot day$

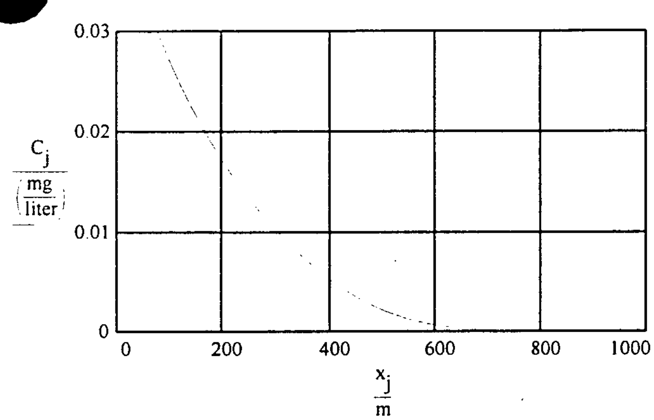
$\Delta x := 1\cdot m$

$x_j := \Delta x\cdot j$

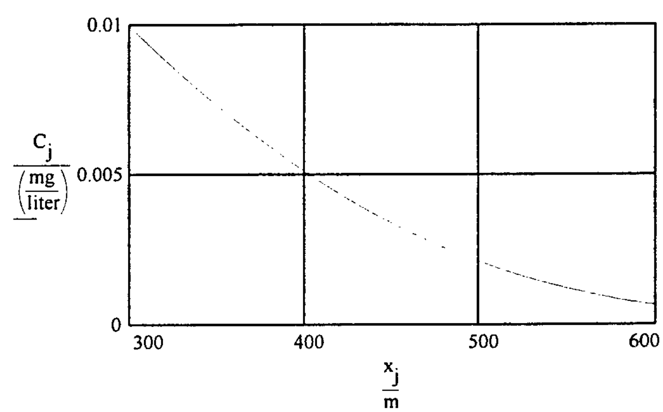
For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

$$
\begin{aligned}
C_j :=\; & C_o\cdot\exp(-\lambda\cdot t)\cdot\left[1-\frac{1}{2}\cdot\left(1-\mathrm{erf}\left(\frac{R\cdot x_j-v_x\cdot t}{2\cdot\sqrt{D_x\cdot R\cdot t}}\right)\right)-\left(\frac{v_x{}^2\cdot t}{\pi\cdot D_x\cdot R}\right)\cdot\exp\left[-\frac{\left(R\cdot x_j-v_x\cdot t\right)^2}{4\cdot D_x\cdot R\cdot t}\right]+\frac{1}{2}\cdot\left(1+\frac{v_x\cdot x_j}{D_x}+\frac{v_x{}^2\cdot t}{D_x\cdot R}\right)\cdot\exp\left(\frac{v_x\cdot x_j}{D_x}\right)\cdot\left(1-\mathrm{erf}\left(\frac{R\cdot x_j+v_x\cdot t}{2\cdot\sqrt{D_x\cdot R\cdot t}}\right)\right)\right]\ldots \\
& +C_s\cdot\exp(-\gamma\cdot t)\cdot\Bigg[\left[\frac{v_x}{v_x+v_x\cdot\sqrt{1+\frac{4\cdot D_x\cdot R}{v_x{}^2}\cdot(\lambda-\gamma)}}\right]\cdot\exp\left[\frac{\left[v_x-v_x\cdot\sqrt{1+\frac{4\cdot D_x\cdot R}{v_x{}^2}\cdot(\lambda-\gamma)}\right]\cdot x_j}{2\cdot D_x}\right]\cdot\left[1-\mathrm{erf}\left[\frac{R\cdot x_j-t\cdot\left[v_x\cdot\sqrt{1+\frac{4\cdot D_x\cdot R}{v_x{}^2}\cdot(\lambda-\gamma)}\right]}{2\cdot\sqrt{D_x\cdot R\cdot t}}\right]\right]\ldots \\
& +\left[\frac{v_x}{v_x-v_x\cdot\sqrt{1+\frac{4\cdot D_x\cdot R}{v_x{}^2}\cdot(\lambda-\gamma)}}\right]\cdot\exp\left[\frac{\left[v_x+v_x\cdot\sqrt{1+\frac{4\cdot D_x\cdot R}{v_x{}^2}\cdot(\lambda-\gamma)}\right]\cdot x_j}{2\cdot D_x}\right]\cdot\left[1-\mathrm{erf}\left[\frac{R\cdot x_j+t\cdot v_x\cdot\sqrt{1+\frac{4\cdot D_x\cdot R}{v_x{}^2}\cdot(\lambda-\gamma)}}{2\cdot\sqrt{D_x\cdot R\cdot t}}\right]\right]\ldots \\
& +\left[\frac{v_x{}^2}{2\cdot D_x\cdot R\cdot(\lambda-\gamma)}\right]\cdot\exp\left[\frac{v_x\cdot x_j}{D_x}-(\lambda-\gamma)\cdot t\right]\cdot\left(1-\mathrm{erf}\left(\frac{R\cdot x_j+v_x\cdot t}{2\cdot\sqrt{D_x\cdot R\cdot t}}\right)\right)\Bigg]
\end{aligned}
$$

Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Sensitivity Analysis of Total Organic Carbon Content (2 times more than observed value)

Initial Plume Distribution Calculation

$j := 0 .. 3000 \qquad t := 730 \cdot day$

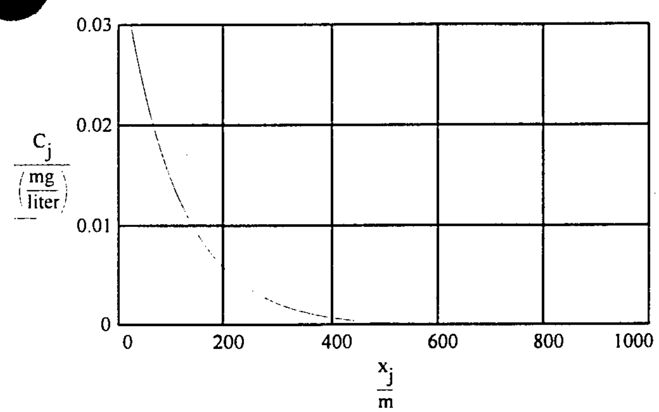
$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

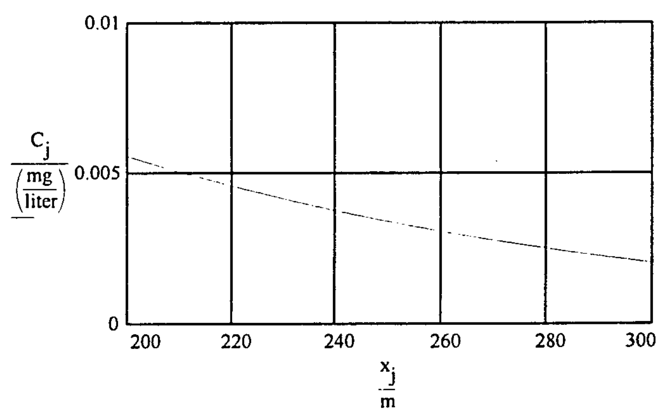
For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

$$
\begin{aligned}
C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \Bigg[& 1 - \frac{1}{2} \cdot 1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right) - \left(\frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R}\right) \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \Bigg] \ldots \\
+ C_s \cdot \exp(-\gamma \cdot t) \cdot \Bigg[& \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right] \cdot x_j}{2 \cdot D_x}\right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right]\right] \ldots \\
& + \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right] \cdot x_j}{2 \cdot D_x}\right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right]\right] \ldots \\
& + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)}\right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t\right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \Bigg]
\end{aligned}
$$

Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Sensitivity Analysis of Total Organic Carbon Content (2 times less than observed value)

Initial Plume Distribution Calculation

$j := 0..3000 \qquad t := 730\cdot day$

$\Delta x := 1\cdot m$

$x_j := \Delta x\cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

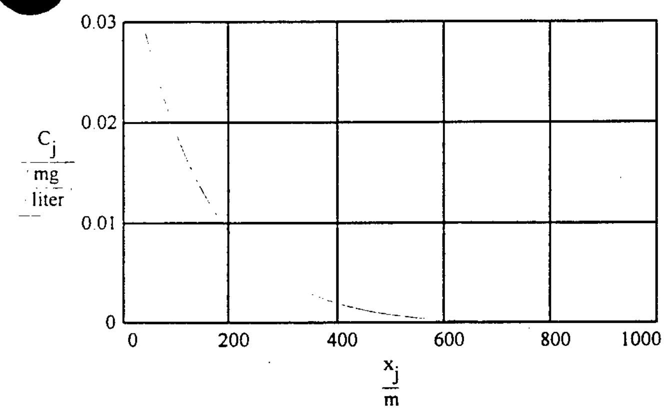
$$C_j := C_o\cdot\exp(-\lambda\cdot t)\cdot\left[1-\frac{1}{2}\cdot\left(1-\mathrm{erf}\left(\frac{R\cdot x_j-v_x\cdot t}{2\cdot\sqrt{D_x\cdot R\cdot t}}\right)\right)-\left(\frac{v_x^2\cdot t}{\pi\cdot D_x\cdot R}\right)\cdot\exp\left[-\frac{(R\cdot x_j-v_x\cdot t)^2}{4\cdot D_x\cdot R\cdot t}\right]+\frac{1}{2}\cdot\left(1+\frac{v_x\cdot x_j}{D_x}+\frac{v_x^2\cdot t}{D_x\cdot R}\right)\cdot\exp\left(\frac{v_x\cdot x_j}{D_x}\right)\cdot\left(1-\mathrm{erf}\left(\frac{R\cdot x_j+v_x\cdot t}{2\cdot\sqrt{D_x\cdot R\cdot t}}\right)\right)\right]\ldots$$

$$+C_s\cdot\exp(-\gamma\cdot t)\cdot\left[\left[\frac{v_x}{v_x+v_x\cdot\sqrt{1+\frac{4\cdot D_x\cdot R}{v_x^2}\cdot(\lambda-\gamma)}}\right]\cdot\exp\left[\frac{\left[v_x-v_x\cdot\sqrt{1+\frac{4\cdot D_x\cdot R}{v_x^2}\cdot(\lambda-\gamma)}\right]\cdot x_j}{2\cdot D_x}\right]\cdot\left[1-\mathrm{erf}\left[\frac{R\cdot x_j-t\cdot\left[v_x\cdot\sqrt{1+\frac{4\cdot D_x\cdot R}{v_x^2}\cdot(\lambda-\gamma)}\right]}{2\cdot\sqrt{D_x\cdot R\cdot t}}\right]\right]\ldots\right.$$

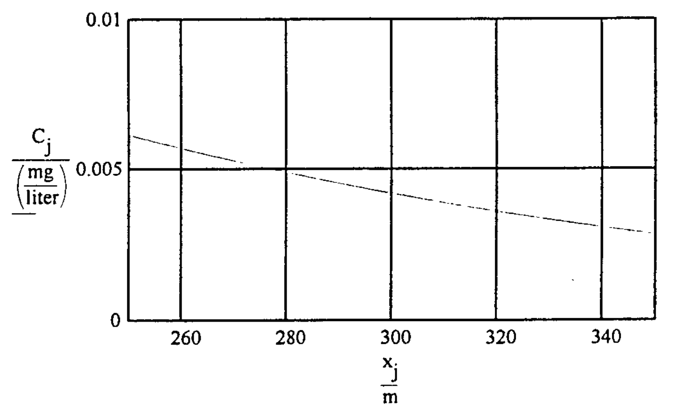
$$+\left[\frac{v_x}{v_x-v_x\cdot\sqrt{1+\frac{4\cdot D_x\cdot R}{v_x^2}\cdot(\lambda-\gamma)}}\right]\cdot\exp\left[\frac{\left[v_x+v_x\cdot\sqrt{1+\frac{4\cdot D_x\cdot R}{v_x^2}\cdot(\lambda-\gamma)}\right]\cdot x_j}{2\cdot D_x}\right]\cdot\left[1-\mathrm{erf}\left[\frac{R\cdot x_j+t\cdot v_x\cdot\sqrt{1+\frac{4\cdot D_x\cdot R}{v_x^2}\cdot(\lambda-\gamma)}}{2\cdot\sqrt{D_x\cdot R\cdot t}}\right]\right]\ldots$$

$$\left.+\left[\frac{v_x^2}{2\cdot D_x\cdot R\cdot(\lambda-\gamma)}\right]\cdot\exp\left[\frac{v_x\cdot x_j}{D_x}-(\lambda-\gamma)\cdot t\right]\cdot\left(1-\mathrm{erf}\left(\frac{R\cdot x_j+v_x\cdot t}{2\cdot\sqrt{D_x\cdot R\cdot t}}\right)\right)\right]$$

Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Sensitivity Analysis of Dispersivity (2 times greater than observed value)

Initial Plume Distribution Calculation

$j := 0 .. 3000 \qquad t := 730 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

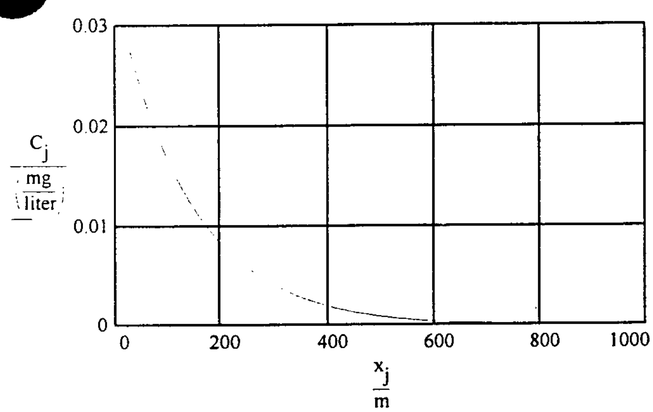
$$C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) - \left(\frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \right) \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t} \right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R} \right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x} \right) \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \mathrm{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

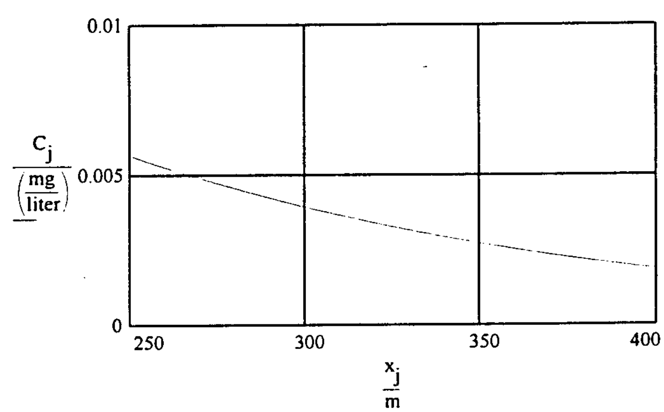
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \mathrm{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \mathrm{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) \right]$$

Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Sensitivity Analysis of Dispersivity (2 times greater than observed value)

Initial Plume Distribution Calculation

$j := 0..3000 \qquad t := 730 \cdot \mathrm{day}$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

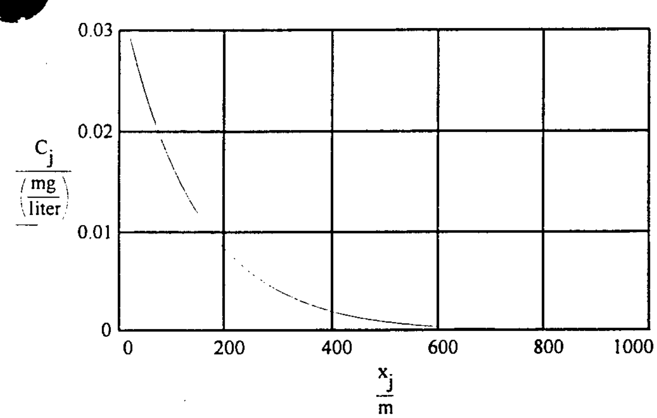
$$C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) - \left(\frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \right) \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t} \right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R} \right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x} \right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

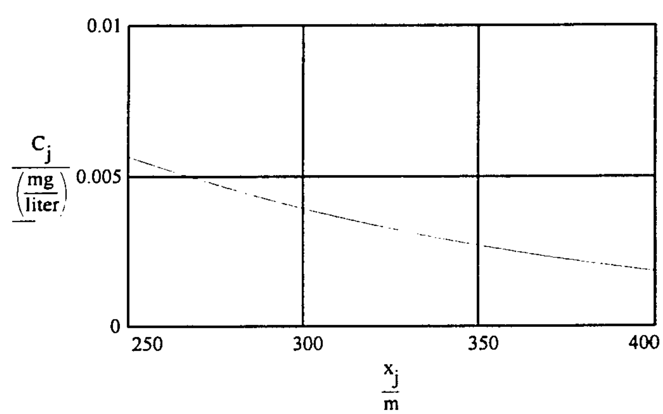
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) \right]$$

Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



APPENDIX D

COST ESTIMATE CALCULATIONS

Present Worth Analysis Annual Adjustment Factor = 7%

Alternative 1: Natural Attenuation th Institutional Controls and -Term Groundwater Monitoring	years	Present Worth ($)	Year: 1	2	3	4	5	6	7	8	9	10
			Cost ($) at Year Indicated									
Maintain Institutional Controls	10	$35,118	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Long-term Monitoring												
Install New Wells	1	$19,814	$21,201	$0	$0	$0	$0	$0	$0	$0	$0	$0
Groundwater Sampling (annual)	10	$94,362	$13,435	$13,435	$13,435	$13,435	$13,435	$13,435	$13,435	$13,435	$13,435	$13,435
Groundwater Sampling (every other year)	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Reporting/Project Mgmt (annual)	10	$33,341	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747
Subtotal Present Worth ($)		$182,635										

Total Present Worth Cost ($): $182,635

Present Worth Analysis Annual Adjustment Factor = 7%

Alternative 2: Natural Attenuation and Sparging System with Institutional Controls and Long-Term Monitoring	years	Present Worth ($)	Year: 1	2	3	4	5	6	7	8	9	10
			Cost ($) at Year Indicated									
Sparging System												
System Installation	1	$234,925	$251,370	$0	$0	$0	$0	$0	$0	$0	$0	$0
System Maintenance	10	$357,079	$50,840	$50,840	$50,840	$50,840	$50,840	$50,840	$50,840	$50,840	$50,840	$50,840
Annual Report	10	$39,866	$5,676	$5,676	$5,676	$5,676	$5,676	$5,676	$5,676	$5,676	$5,676	$5,676
Subtotal Present Worth ($)		$631,870										
Maintain Institutional Controls	10	$35,118	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Long-term Monitoring												
Install New Wells	1	$19,814	$21,201	$0	$0	$0	$0	$0	$0	$0	$0	$0
Groundwater Sampling (annual)	10	$94,362	$13,435	$13,435	$13,435	$13,435	$13,435	$13,435	$13,435	$13,435	$13,435	$13,435
roundwater Sampling (every other year)	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
eporting/Project Mgmt (annual)	10	$33,341	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747
Subtotal Present Worth ($)		$182,635										

Total Present Worth Cost ($): $814,505

Present Worth Analysis Annual Adjustment Factor = 7%

Alternative 3: Natural Attenuation and Groundwater Extraction and Treatment with Institutional Controls and Long-Term Monitoring	years	Present Worth ($)	Year: 1	2	3	4	5	6	7	8	9	10
			Cost ($) at Year Indicated									
Groundwater Pump and Treat System												
System Installation	1	$396,735	$424,507	$0	$0	$0	$0	$0	$0	$0	$0	$0
System Maintenance	5	$239,206	$58,340	$58,340	$58,340	$58,340	$58,340	$0	$0	$0	$0	$0
Annual Report	5	$30,772	$7,505	$7,505	$7,505	$7,505	$7,505	$0	$0	$0	$0	$0
Subtotal Present Worth ($)		$666,713										
Maintain Institutional Controls	10	$35,118	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Long-term Monitoring												
Install New Wells	1	$19,814	$21,201	$0	$0	$0	$0	$0	$0	$0	$0	$0
Groundwater Sampling (annual)	10	$94,362	$13,435	$13,435	$13,435	$13,435	$13,435	$13,435	$13,435	$13,435	$13,435	$13,435
Groundwater Sampling (every other year)	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Reporting/Project Mgmt (annual)	10	$33,341	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747
Subtotal Present Worth ($)		$182,635										

Total Present Worth Cost ($): $849,348

Alternatives 1, 2, and 3: Long-Term Monitoring and Institutional Controls

Standard Rate Schedule

ling egory Cost Code/(Billing Category)	Billing Rate	Task 1 (hrs)	Install New LTM/POC Wells ($)	Task 2 (hrs)	Sampling ($)	Task 3 (hrs)	Reporting & PM ($)
Word Processor 88/(15)	$30	0	$0	0	$0	8	$240
CADD Operator 58/(25)	$47	4	$188	0	$0	16	$752
Technician 42/(50)	$40	10	$400	30	$1,200	10	$400
Staff Level 16/(65)	$57	80	$4,560	30	$1,710	20	$1,140
Project Level 12/(70)	$65	4	$260	4	$260	10	$650
Senior Level 10/(80)	$85	1	$85	0	$0	3	$255
Principal 02/(85)	$97	0	$0	0	$0	0	$0
Total Labor (hrs | $)		99	$5,493	64	$3,170	67	$3,437
ODCs							
Phone			$30		$0		$50
Photocopy			$20		$0		$150
Mail			$100		$400		$60
Computer			$150		$0		$400
CAD			$0		$0		$450
WP			$0		$0		$200
Travel			$1,000		$2,000		$0
Per Diem			$1,358		$780		$0
Eqpt. & Supplies			$400		$200		$0
l ODCs			$3,058		$3,380		$1,310
Outside Services							
LTM/POC Well Installation Costs [a/]			$12,650		$0		$0
Laboratory Fees [b/]			$0	14 LTM, 3 qa/qc	$6,885		$0
Other: Maintain Institutional Controls			$0		$0		$5,000
Total Outside Services			$12,650		$6,885		$5,000

Proposal Estimate	Task 1	Task 2	Task 3
Labor	$5,493	$3,170	$3,437
ODC's	$3,058	$3,380	$1,310
Outside Services	$12,650	$6,885	$5,000
Total by Task	$21,201	$13,435	$9,747

Total Labor	$12,100
Total ODCs	$7,748
Total Outside Services	$24,535
Total Project	$44,383

Task 1: Install New LTM/POC Wells

sk 2: Sampling per Event

3: Reporting and PM per Sampling Event

Alternative 3: Groundwater Extraction and Treatment System

Standard Rate Schedule

Billing Category Cost Code/(Billing Category)	Billing Rate	Task (hrs)	Design & Install Recovery System ($)	Task 2 (hrs)	System Monitoring/ Maintenance (weekly/1 yr.)($)	Task 3 (hrs)	Completion Report ($)
Word Processor 88/(15)	$30	40	$1,200	0	$0	8	$240
CADD Operator 58/(25)	$47	140	$6,580	0	$0	16	$752
Technician 42/(50)	$40	450	$18,000	400	$16,000	16	$640
Staff Level 16/(65)	$57	450	$25,650	100	$5,700	64	$3,648
Project Level 12/(70)	$65	150	$9,750	40	$2,600	24	$1,560
Senior Level 10/(80)	$85	12	$1,020	0	$0	5	$425
Principal 02/(85)	$97	2	$194	0	$0	0	$0
Total Labor (hrs | $)		1244	$62,394	540	$24,300	133	$7,265
ODCs							
Phone			$200		$60		$10
Photocopy			$100		$0		$50
Mail			$100		$120		$40
Computer			$200		$0		$40
CAD			$240		$0		$60
WP			$100		$0		$40
Air fare/Travel (per trip) (two pers. one trip)	$500	2	$1,000	12	$6,000		$0
Vehicle (per day) (16 field, drill and install)	$55	16	$880	24	$1,320		$0
Per Diem (per day)	$85	32	$2,720	24	$2,040		$0
Eqpt. & Supplies	$1,000	1	$1,000		$500		$0
Total ODCs			$6,540		$10,040		$240
Outside Services							
Well Installation			$74,850		$0		$0
Soil Disposal			$1,500		$0		$0
Equipment Costs			$189,000		$0		$0
System Installation			$57,080		$0		$0
Contingency (10 % of above services)			$32,243		$0		$0
Analytical (initial 3 samp., 3 per mnth plus QC)	$300	3	$900	40	$12,000		$0
Local Subcontractor (maintenance)	$1,000		$0	12	$12,000		$0
Total Outside Services			$355,573		$24,000		$0

Estimate		Task 1	Task 2	Task 3
Labor		$62,394	$24,300	$7,265
ODC's		$6,540	$10,040	$240
Outside Services		$355,573	$24,000	$0
Total by Task		$424,507	$58,340	$7,505
Total Labor		$93,959		
Total ODCs		$16,820		
Total Outside Services		$379,573		
Total Project		$490,352		

Task 1: Groundwater pump and treat system design and installation and report

Task 2: Monthly Site Time and Travel Costs (per year)

Task 3: Report Preparation

Alternative 2: Sparging

Standard Rate Schedule

Billing Category Cost Code/(Billing Category)		Billing Rate	Task 1 (hrs)	Design & Install Sparge System ($)	Task 2 (hrs)	System Monitoring/ Maintenance (monthly / 1 yr)	Task 3 (hrs)	Completion Report ($)
Word Processor	88/(15)	$30	40	$1,200	0	$0	8	$240
CADD Operator	58/(25)	$47	150	$7,050	0	$0	8	$376
Technician	42/(50)	$40	300	$12,000	400	$16,000	16	$640
Staff Level	16/(65)	$57	300	$17,100	100	$5,700	40	$2,280
Project Level	12/(70)	$65	120	$7,800	40	$2,600	24	$1,560
Senior Level	10/(80)	$85	20	$1,700	0	$0	4	$340
Principal	02/(85)	$97	2	$194	0	$0	0	$0
Total Labor (hrs|$)			932	$47,044	540	$24,300	100	$5,436
ODCs								
Phone				$200		$60		$10
Photocopy				$100		$0		$50
Mail				$100		$120		$40
Computer				$200		$0		$40
CAD				$240		$0		$60
WP				$100		$0		$40
Air fare/Travel (per trip) (2 per., pilot & install)		$500	4	$2,000	12	$6,000		$0
Vehicle (per day) (22 days, pilot and install)		$55	22	$1,210	24	$1,320		$0
Per Diem (per day)		$85	44	$3,740	24	$2,040		$0
Eqpt. & Supplies		$500	1	$500	1	$500		$0
Total ODCs				$8,390		$10,040		$240
Outside Services								
Well Installation				$110,750		$0		$0
Disposal				$2,000		$0		$0
Equipment Costs				$10,500		$0		$0
System Installation				$52,146		$0		$0
Contingency (10 % of above services)				$17,540		$0		$0
Analytical (pilot test 5, 5 bimonthly plus QC)		$300	10	$3,000	35	$10,500		$0
Local Subcontractor (maintenance)		$500	0	$0	12	$6,000		$0
Carbon		$500	0	$0	0	$0		$0
Total Outside Services				$195,936		$16,500		$0

Estimate		Task 1	Task 2	Task 3
Labor		$47,044	$24,300	$5,436
ODC's		$8,390	$10,040	$240
Outside Services		$195,936	$16,500	$0
Total by Task		$251,370	$50,840	$5,676
Total Labor		$76,780		
Total ODCs		$18,670		
Total Outside Services		$212,436		
Total Project		$307,886		

Task 1: SVE/Sparge system deisgn and installation and report
Task 2: Monthly Site Time and Travel Costs (per year)
Task 3: Report Preparation

Columbus AFB Backup Calculations

Alternatives 1, 2 and 3: Long-term Monitoring

Misc calculations

New LTM wells:		
Number of wells:	6	
Depth each:	25	ft

Cost calculations

Description	Unit	Qty.	Unit Price	Subtotal	Total	Source (If applicable)
Well Installation					$ 11,500	
Mobilization	ea	1	$ 2,000	$ 2,000		
Well Installation	ln ft	150	$ 50	$ 7,500		
Soil Disposal	drum	20	$ 100	$ 2,000		
Subtotal	-	-	-		$ 11,500	
Contingency	ls	10%	$ 11,500	$ 1,150	$ 1,150	
TOTAL					**$ 12,650**	

Columbus AFB Backup Calculations

ernative 2: Sparge System

Misc calculations

Number of vent/sparge wells:		
Number of sparge wells:	45 x 30	ft
Number of SVE wells:	0 x 15	ft
Disposal Fees		
Soil Disposal		
Equipment Costs		
Trench Volume/Area		
Width:	1	ft
Depth:	3.5	ft
Length:	950	ft
Volume:	3,325	cf
	123	cy
Surface Area:	950	sf
	106	sy

Cost calculations

Description	Unit	Qty.	Unit Price	Subtotal	Total	Source (If applicable)
Well Installation					$ 110,750	
Mobilization	ea	2	$ 1,500	$ 3,000		Assuming 2 xmobe , one for pilot test
Well Installation	ln ft	1,350	$ 75	$ 101,250		Assumes no surface completion
Vapor mon. pts.	ea	5	$ 1,000	$ 5,000		Estimate
PID and misc equi	day	12	$ 125	$ 1,500		Estimate
					$ 2,000	
Soil Disposal	drum	20	$ 100	$ 2,000		Assuming non-hazadous
Equipment Costs					$ 10,500	
SVE blower/syste	ea	-	$ 10,000	$ -		
Sparge blower	ea	1	$ 4,500	$ 4,500		Skid-mounted
Electronics & PLC	ea	2	$ 2,500	$ 5,000		Estimate
Valves, gauges, ho	ls	1	$ 1,000	$ 1,000		Estimate
Carbon	ea	-	$ 1,000	$ -		Assume 2 x 55 gallon drums in series
System Installation					$ 52,146	
Mob/Demob	ea	1	$1,500	$ 1,500		Estimate
Trenching	cy	123	$5.05	$ 622		Means 022 254 0050
Pipe laying	ln ft	950	$13.05	$ 12,398		Means 151 701 0550/026 686 2800
Backfill	cy	123	$17.20	$ 2,118		Means 022 204 0600
Compaction	cy	123	$5.10	$ 628		Means 022 204 0600
Pavement Base	sy	106	$5.25	-		Means 022 308 0100
Reseeding	sy	106	$ 2	$ 202		Means 029 304 0310
Piping	lf	950	$9.30	$ 8,835		Means 151 551 1880
Mechanical	man hr	40	$ 39	$ 1,553		Means Q-1 crew
Electrical	ls	1	$ 4,000	$ 4,000		Estimate for electrician
Electrical supply	ls	1	$ 10,000	$ 10,000		Estimate to provide power supply
Slab	cy	3	$97.00	$ 291		Means 033 130 4700
Building	ls	1	$10,000	$ 10,000		Estimate, (residential area)
Subtotal	-	-	-		$ 175,396	
Contingency	ls	10%	$ 175,396	$ 17,540	$ 17,540	
TOTAL					**$ 192,936**	

Columbus AFB Backup Calculations

ernative 3: Groundwater Extraction System

Misc calculations

Number of recovery wells		
10-inch recovery wells	8 x 55	ft
Disposal		
Soil Disposal		
Trench Volume/Area		
Width:	1	ft
Depth:	3.5	ft
Length:	550	ft
Volume:	1,925	cf
	71	cy
Surface Area:	550	sf
	61	sy

Cost calculations

Description	Unit	Qty.	Unit Price	Subtotal	Total	Source (If applicable)
Well Installation					$ 74,850	
Mobilization	ea	1	$ 2,000	$ 2,000		Assuming 2 xmobe , one for pilot test
Well Installation	ln ft	440	$ 140	$ 61,600		Includes well devel., screen, steel case.
Add. monitor. pts.	ea	5	$ 2,000	$ 10,000		Estimate
PID and misc equi	day	10	$ 125	$ 1,250		Estimate
					$ 1,500	
Soil Disposal	drum	15	$ 100	$ 1,500		Assuming non-hazadous
Equipment Costs					$ 189,000	
Submersible pump	ea	8	$ 2,500	$ 20,000		Estimate
Air Stripper	ea	1	$ 160,000	$ 160,000		Estimate, 1800 gpm
Electronics & PLC	ea	1	$ 7,500	$ 7,500		Estimate
Valves, gauges, ho	ls	1	$ 1,500	$ 1,500		Estimate
System Installation					$ 57,080	
Mob/Demob	ea	1	$1,500	$ 1,500		Estimate
Trenching	cy	71	$5.05	$ 360		Means 022 254 0050
Pipe laying	ln ft	550	$13.05	$ 7,178		Means 151 701 0550/026 686 2800
Well vault boxes	ea	8	$1,200	$ 9,600		Estimate, concrete with spring cover
Backfill	cy	71	$17.20	$ 1,226		Means 022 204 0600
Compaction	cy	71	$5.10	$ 364		Means 022 204 0600
Pavement Base	sy	61	$5.25	-		Means 022 308 0100
Reseeding	sy	61	$ 2	$ 117		Means 029 304 0310
Piping	lf	550	$9.30	$ 5,115		Means 151 551 1880
Mechanical	man hr	60	$ 39	$ 2,330		Means Q-1 crew
Electrical	ls	1	$ 4,000	$ 4,000		Estimate for electrician
Electrical supply	ls	1	$ 10,000	$ 10,000		Estimate to provide power supply
Slab	cy	3	$97.00	$ 291		Means 033 130 4700
Building	ls	1	$15,000	$ 15,000		Estimate, (needed for residen.area)
Subtotal	-	-	-		$ 322,430	
Contingency	ls	10%	$ 322,430	$ 32,243	$ 32,243	
TOTAL					**$ 354,673**	